TO EVALUATE THE ROLE OF TENSION BAND WIRING AS A METHOD OF INTERNAL FIXATION IN VARIOUS FRACTURES

# THESIS

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UMESH SINGH

# C E R T I F I C A T E

This is to certify that the work entitled "TO EVALUATE THE ROLE OF TENSION BAND WIRING AS A METHOD OF INTERNAL FIXATION IN VARIOUS FRACTURES" which is being submitted as a THESIS for M.S.(Orthopaedics) Examination, 1991 of Bundelkhand University by UMESH SINGH, has been carried out in the Department of Orthopaedics, M.L.B. Medical College, Jhansi.

He has put in the necessary stay in the department of Orthopaedics according to university regulations.

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The techniques embodied in the thesis were undertaken by the candidate himself and observations recorded have been checked by me.

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Dated :

( Umesh Singh )

# CONTENTS

# INTRODUCTION

# INTRODUCTION

Since very beginning, rather we can say with their development people are predisposed to various kinds of trauma. With rapid civilisation dynamicity of life is increasing. In this modern era of rapid developments in industrialization, traffic, agriculture different kinds of trauma are becoming more and more common, so fractures are bound to occur. Incidence of various fracture is increasing day by day, thanks to fast moving vehicles and industrialisation. Fractures of olecranon process, patella and malleoli, although not among the commonest yet they too have their share of increased incidence.

Regarding the latter fractures various modalities have been tried ranging from conservative treatment by reduction and plaster immobilization on one hand to open reduction and internal fixation by various methods on the other.

When we consider present busy and competitive life conservative treatment by prolonged plaster immobilization is not entirely justified because every injured person wants to joint his job as early as possible as he cannot afford to be away from his job for prolonged period.

Disadvantage of conservative treatment is that, it takes long time to heal necessitating prolonged plaster immobilization. As a corollary joint stiffness,

muscular atrophy, plaster and bed sores and post immobilization oedema follow which adds to prolonged morbidity.

When we evaluate conservative treatment of these fractures many complications are seen. As in case of olecranon fracture when limb is immobilised in full extension, flexion is reduced and if early flexion is allowed it leads to lack of full extension.

Problem in conservative management of many displaced malleolar fractures is nonunion leading to instability of joint or incongurous joint surfaces leading to late osteoarthritis. Similar is the problem with displaced fractures of patella in which conservative treatment always yields irregular articular surface and late patellofemoral osteoarthritis.

To overcome these problems of conservative treatment, various methods of internal fixation have been developed. Internal fixation provides direct access to fracture site, anatomical reduction under vision, and secure rigid fixation . This also obviates problems related with soft tissue interposition. A good internal fixation does not require prolonged plaster immobilisation.

Most modern techniques aim to achieve bony union in exact anatomical position with fixation sufficient to withstand disruptive effects of early active exercises. association for study of osteosynthesis (A.O.) have developed methods of rigid fixation and compression for

internal fixation of fractures. The rigidity provided by these methods is used for active and functional treatment throughout bone healing.

For these fractures A.O. group has recommended tension band wiring which converts distraction forces acting on tension side of fracture surface into compression forces. Rigidity, stability and painlessness provided by these methods is utilised for active and functional treatment throughout union. Principle of tension band wiring as applied to fracture treatment was described by Pauwel . He said a surface implant absorbs all tension and further pull merely increases compression across whole fracture site. Initially he used this method for fractures of patella, intertrochantric varus osteotomy and long standing pseudoarthrosis of femur. Later this method was popularised by Weber and Vasey when they used this method for fracture of olecranon and patella. Muller et al used this technique for other fractures like malleoli, lateral end of clavicle and greater trochanter.

This technique is very important for amanagement of intra-articular fractures like olecranon, patella and medial malleolus where reconstruction of joint surfaces and secure fixation of fracture fragments is instituted to avoid complication of prolonged plaster immobilisation.

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## AIMS OF STUDY

Our aim in present study is to evaluate the role of tension band wiring as a method of internal fixation in various fractures.

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# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Since immemorial time man is facing problems of accident and injuries and is trying well to manage. them. It will not be improper to say that history of fractures and their treatment dates back with development of human race on the earth. Because no mode of recording the event existed in those times, the data regarding methods of treatment practiced during that period are not available.

In Indian literature earliest references regarding healing of bones are seen in Atharva Ved(some 2000 B.C.). Later on Samhitas of Charak and Sushruta (about 1000 B.C.) deal with diagnosis and treatment of various types of fractures and dislocations (Keswani,1967). They either treated by means of pulley(Chakra), or immobilised fractures by bandha (Bandage) bark splints or bamboo strips.

In modern era, fractures are basically treated by two methods i.e. conservatively by plaster immobilisation; and open reduction and internal fixation by various means.

Conservative management of fractures has many disadvantages as it needs prolonged plaster immobilisation, which leads to joint stiffness, muscular atrophy, sore, disuse osteoporosis, post immobilisation oedema and damage to articular cartilage due to hampered nutrition.

With these also accompany general complications of prolonged immobilisation as embolism, phlebitis, renal calculi, and hypostatic pneumonia.

There are so many specific problems, many of fractures as in fracture olecranon when a limb is immobilised in extension, flexion becomes limited an d if splinted in flexion leads to fibrous union. With lack of full extension so conservative treatment of olecranon at best can result in fibrous union with lack of full movement or with unstable elbow if fracture is associated with dislocation inaccurate reduction of articular surface as also in fractures of malleoli and patella leads to secondary osteoarthritis.

Lastly conservative treatment keeps away many patients from their jobs for prolonged times which creates many economic and social problems.

To overcome these complications of conservative treatment various methods of open reduction and internal fixation have been evolved. Advantages of internal fixation are : firstly, it provides reduction under vision, so articular surface can be reconstructed to normal or near normal. It secures rigid fixation and avoids soft tissue interposition, thus minimising incidence of secondary osteoarthritis and nonunion.

Since beginning various methods of internal fixation varying from very primitive one to very sophisticated newer ones have been developed.

History of internal fixation is very old and dates back with historical event of antisepsis i.e. carbolic spray. Then it was used by Lister (1883) in case of fracture olecranon which was treated by iron wires (Howard and Urist, 1958). Since that time techniques are improving and have reached upto spring hooks in olecranon, percutaneous tension band wiring of patella, ASIF screw in malleoli, and tension band wiring for many of these fractures.

Most modern techniques aim to achieve bony union in exact anatomical position, despite disruptive effect of early and active exercises. Association for study of osteosynthesis(A.O.) evolved methods utilising rigid fixation and compression for internal fixation of fractures.

AIMS OF A.O. METHODS

Rapid recovery of injured limb : this is accomplished by :

1. Anatomic reduction of fracture fragments particularly those forming joint surface.
2. Stable internal fixation, designed to fulfil the local biomechanical demands.
3. Preservation of blood supply to the bone fragments and soft tissues by means of atraumatic surgery.
4. Early active pain free mobilisation of muscles and joints adjacent to fractures. This full active pain free mobilisation results in a rapid return to normal of blood supply to both bone and soft tissue. It also

enhances articular cartilage nutrition, by synovial fluid and when combined with partial weight bearing it greatly decreases post traumatic osteoporosis by restoring an equilibrium between bone resorption and bone formation. They not only result in painfree convalscence but also in a considerably shortening hospitalisation time and thus decreasing cost of medical care without lowering standard of treatment. It also decrease period of disability and incidence of post traumatic dystrophies, malunion and pseudoarthrosis.

All these merits are achieved by tension band wiring (a method of dynamic compression) in cases of intra-articular fractures of olecranon, patella, malleoli, and also in others like fracture of lateral end of clavicle.

Principle of tension band fixation was demonstrated by Pauwels F. He borrowed the idea from mechanics.

When a bone is loaded in its axis a axial compression stress is produced depending on magnitude of load (directly proportional) and cross section of bone(inversely proprotion). When a bone is loaded eccentrically a bending stress is produced in addition to axial compression. This bending results in typical distribution with tensile stress on convex side (opposite side) and compressive stress on concave side. If a second weight of same magnitude is put at same distance but on opposite direction, it neutralizes bending stress of first one and also

creates additional axial compression. This weight can be represented by tension band (wire or plate). Prestressing of a plate results in inter-fragmental compression. Loading results in a dynamic increase in axial interfragmental compression. Tension band wiring can be employed in those cases where it can absorb all the tensile forces and where the bending shearing forces are overcome by the friction and impaction of the fragment or by a supplementary K. wire fixation which serves as internal splinting.

Schematic drawing after Pauwels illustrating differences between load and stress and principle of tension band fixation is shown in the diagram No. ).

A. If a column with a surface area of 10 $cm^2$ is loaded axially with 100 kp it creates pure axial compression

$$D = 10\ kp/cm^2$$

B. If a column is now subjected to eccentric loading we have not only the axial compression stresses but also additional bending stresses which give rise to further compressive stresses and tensile stresses. In this example bending stress due to eccentric loads was 40 $kp/cm^2$, these are added to axial compression on compression side (40+10), 50 $kp/cm^2$ but are substracted on tensile side (40-10) = 30 $kp/cm^2$ C.D.. These bending stresses can be neutralised by a second weight which is placed on opposite side and equidistant from centre of column. This second weight can be compared to tension band. Although load has increased(200 kp)

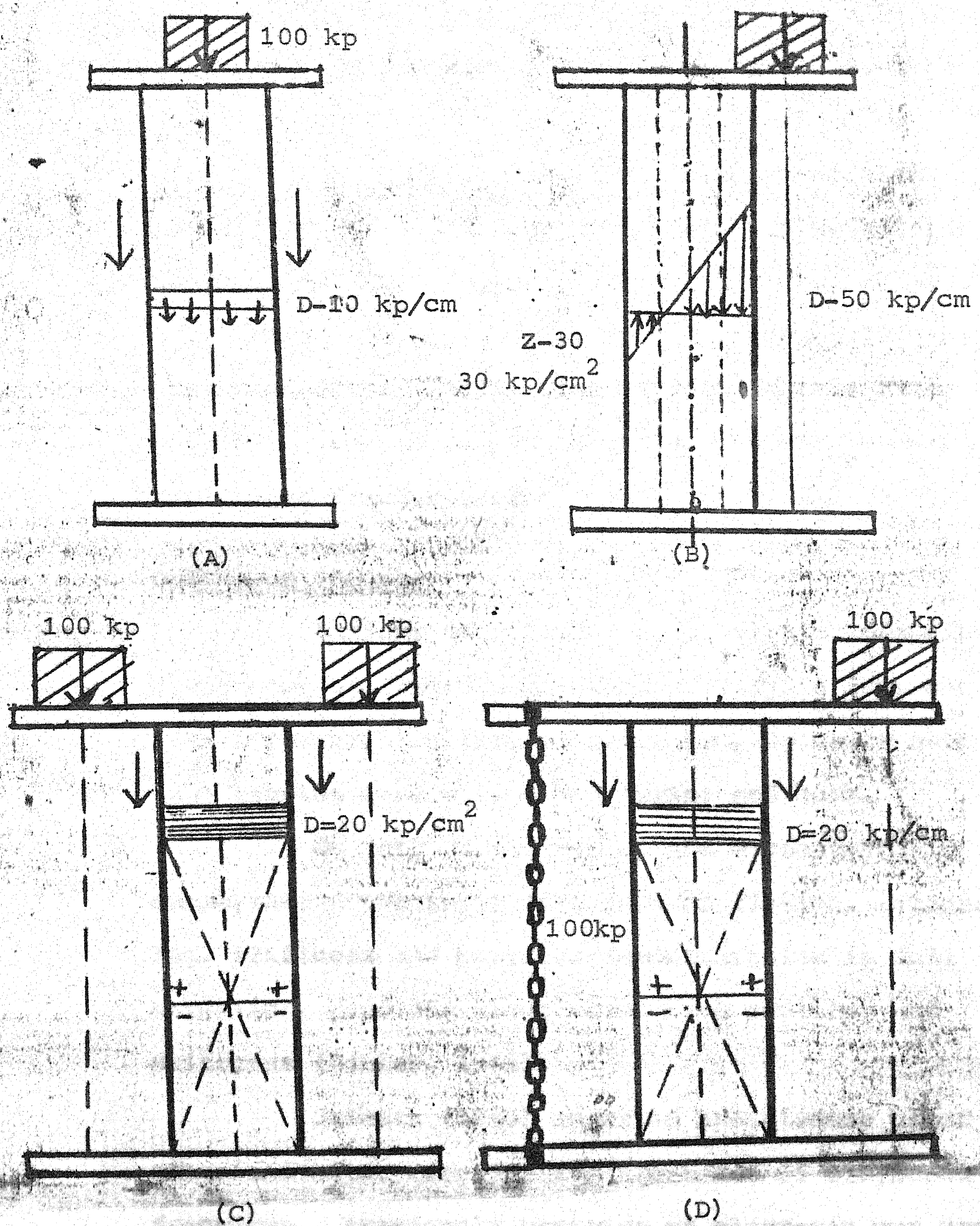



Diagram No. 1 : Showing Pauwel's principle.

the total stress is reduced to fifth(D=20 kp/cm$^2$) because bending stresses have been neutraliased.

Pauwels first demonstrated tension band wiring in large series of fractures osteotomies and pseudoarthrosis.

In 1963, interest in tension band wiring was revived by Weber and Vasey who used this method for fixation of fractures of patella and olecranon. Later on this method was popularised by Muller et al(1970) when they used method to fix other fractures like those of malleoli, lateral end of clavicle, greater trochanter along with fractures of olecranon and patella.

OLECRANON PROCESS

Various modalities are available regarding management of fracture olecranon. Varying from conservative method, excision of olecranon, to newer methods like tension band wiring and spring and hook.

So many complications are encountered in conservative treatment like lack of flexion, extensor lag, stiffness and wasting. Immobilization in full extension, produces troublesome hand swelling and stiffness (Bohler, 1965).

Stewart (1960) reported troublesome ulnar nerve adhesions after conservative treatment of olecranon fractures. Previously excision of olecranon was recommended by various authorities like Rombold (1934), Amnn (1939), Mckeever and Buck and Adler et al.

Wainwright (1942) reported and results of 20 fractures of olecranon treated by excision and felt that it was superior attempts to effect union in older patients.

Mckeever and Buck (1947) reported results of ten cases of fracture olecranon process treated by excision of fragment. They observed that as much as 80% of trochlear notch, could be removed without danger of producing instability of elbow. They said extensively comminuted fractures and elderly people should be treated by excision of fracture fragment. But he also reported loss of some strength in ability to extend elbow in four patients. Greatest loss of triceps power amounted 25%. He also reported incidence of traumatising ulnar nerve in three patients after excision. They recommended excision as operation of choice in old ununited fractures, fractures that are extensively comminuted and fractures in elederly

Gartsman et al (1981) conducted comparative study of primary excision and open reduction and internal fixation in total of 107 patients. They observed incidence of complications (23%) in group of 54 patients treated by internal fixation and 4% in 53 patients treated by excision of olecranon. They observed no significant statistical difference in either subjective complaints of pain, instability and functional loss or in quantitative

analysis of power. They demonstrated similar diminution of elbow extension.

They documented incidence of instability with anterior subluxation of ulna in a patient in whom 75% olecranon was excised and it required prolonged immobilization leading to stiff elbow. In their operative su-group of 11 patients in whom tension band wiring was applied two minor complications occurred,in one a painful keloid and in another subcutaneous migration of kirschner wires requiring early removal of wires developed.

However, Hey Groves (1939) thought that because of loss of leverage for elbow extension, excision might lead to consequent triceps weakness. Colton did not recommend excision of olecranon as first choice due to possibility of instability of elbow joint.

Retting et al (1979) compared excision and internal fication, they noted no difference in the final range of motion. They also documented 15% incidence of complication in fixation group but they concluded that immediate open reduction and internal fixation are indicated for all fractures where feasible.

Crenshaw considered excision of olecranon as operation of choice only in following conditions :

1. Severely comminuted fractures in which open reduction and internal fixation is not technically possible.

2. Non articular fractures.
3. Failed previous open reduction and internal fixation.
4. Nonunion.
5. When treatment is delayed 10 to 14 days.
6. Type II open fractures.

Advocates of open reduction and internal fixation claim that :

1. This method provides anatomic reduction and congruous articular surfaces.
2. Elbow stability is preserved.
3. Extensor power of triceps is maintained.

Wander Kloot reported uniformly good results in fifty six patients in whom a 'figure of eight' wire loop apposing the fragment was used as method of internal fixation. He thought that there was no need for excision of olecranon.

Mathewson and Mc Creath reviewed forty two fractures of olecranon in forty one patients treated by tension band wiring. Some fractures were associated with dislocation of radial head. Technique consisted in transfixing the fractures with two intramedullary K. wires followed by compression by 'figure of eight' wire loop. He allowed movement one to two weeks after operation.

In cases with radial head dislocation he used nail instead of K. wire. He concluded that this simple method is of choice for all olecranon fractures particularly

those which were comminuted or associated with elbow instability. There were four poor results all due to technical failure. They removed wires routinely after three or four months. He felt 'figure of eight' wire without Kirschner wires some times gave inadequate fixation.

Colton (1973) described classification and management of fracture olecranon in adults. He divided these fractures into four main groups.

1. Avulsion group : In this transverse fracture line separates a small proximal fragment.
2. Oblique group : comprise a range of comminution in which primary plane is oblique starting near the deepest part of trochlear notch and running dorsally and distally to emerge on subcutaneous crest of the proximal part of ulna.
3. Fracture dislocation (Monteggia group) : fracture is at level of top of coronoid process so that plane of instability is present.
4. Unclassifiable.

He described tension band fixation principle of Weber and Vasey as most logical and practical form of fixation. However, he does not think double knob in 'figure of eight' configuration necessary(Weber has suggested that both limbs of figure of eight be twisted in order to increase rigidity of fixation).

In Colton's opinion it makes much more difficult to remove the wire without wide exposure.

He reported that where a central cuneiform fragment is depressed, a frequent finding has been impaction of adjascent cancellus bone of main fragments. This crushed surface is often seen to be smoothly curved. Corresponding to form of trochlear this gap must be packed with cancellus bone from greater trochanter. He thought the younger the patient, the greater the need for anatomical reposition of fragment because elbow joint takes a few years to develop osteoarthritis, where severely comminuted fracture cannot be reconstituted, it should be excised and the gap should not be filled with cancellus bone for fear of its loosening and escape as loose body into joint. He referred to Barford (1972) who described an ingenious technique for excision of comminuted fragment, osteotome should be directed accurately along the radius of trochlear curve at both sites and after that tension band wiring may be performed. Where a sagittal split is present in proximal olecranon, Kirschner wire should be inserted at an acute angle so that when loop is tightened they are also approximated side to side. He recommended that in group 3 fracture where instability is present tension band wiring should not be applied instead intramedullary fixation device should be used.

Benjamin described the tension band wiring as treatment of choice for olecranon fracture. He used two

K. wire and along with 'figure of 8' wire loop passed around ends of protruding K. wires. He recommended double knot on either limb of figure of eight loop.

Holdsworth and Mossad reviewed fifty two cases following displaced fractures of olecranon fixed by tension band wiring with age falling mainly in two groups i.e. 10-25 and 55-70 years. Cases were operated within 48 hours and followed up for 2 years. They reported that function was very good or excellent in 85% cases of the series. Ten percent patients showed a radiological step in post operative radiographs. In 90% cases extension loss was less than 20$^{\circ}$ and 80% cases regained normal extensor strength. Very old patients did less well. They reported loosening of K. wires which caused discomfort and necessitated occasional early removal. Infection and troublesome neuropraxia occurred in one case each. Hypertrophic scar resulted in four patients. They suggested that tension band loop should be buried deep to triceps tendon to avoid loosening of K. wires, because any wire tending to alter the insertion will be prone to loosening as extension is regained.

Fyfe et al (1982), by an independent experimental work on cadaveric elbow, demonstrated that both tension band wires and plates are capable of achieving a high degree of rigidity. Twin tightening knots on figure of eight were needed to equal rigidity of plate fixation.

Maini et al (1986) treated 39 patients of fracture olecranon including comminuted fractures in 18 cases and open fractures in three by tension band wiring technique. Among these 24 were males and 15 were females with average age of 31.6 years ranging from 20 to 50 years. Interval between injury and operation was 5 days to 35 days. They used tension band with two K. wires in 30, double tension band in 6 and single tension band wire in 3 cases. They started active exercises at 10th day after removal of stitches.

At 4 weeks follow up period extension limitation was $0^\circ$ in six, $5^\circ$ in 18, $10^\circ$ in nine, $15^\circ$ in three and $20^\circ$ in three cases. At same follow up flexion range was $90-120^\circ$ in 30, $120-150^\circ$ in six and over $150^\circ$ in three cases. Later at 2 years follow up they observed great improvement in movements and extension lag of $5^\circ$ in 11, $10^\circ$ in one and $15^\circ$ in two cases, was found. Similar improvement was observed in flexion movement as flexion range of $90-120^\circ$ was only in three; $120-150^\circ$ in 10 and over $150^\circ$ was found in 26 cases. They reported excellent results in 18, good in 10 and fair in 3 and no poor results. They observed loosening of K. wires in four cases and no case of nonunion or nerve palsy was seen.

Pandit et al (1986) studied 20 cases of fracture of olecranon treated by tension band wiring. Among these four patients had compound fractures. All were of type I injury. Three had fracture of head radius. All cases

were operated within 72 hours. Post operatively all but three patients were allowed active physiotherapy as pain subsided. They observed that all fractures except two united within three months. Two cases had delayed union i.e. these united after 12 weeks. They graded results as excellent in 15, good in five and no poor results was seen. They found superficial infection in three, inadequate fixation leading to external immobilization in three and stiffness of elbow in three.

They advocated implant removal after six months. They compared results of various devices to fix olecranon as shown in different series of studies conducted by different authorities and found that tension band wiring provided better results as compared with other devices.

Donald Macko et al (1985) studied 20 cases of displaced fracture of olecranon treated by tension band wiring with average age of 35.5 years for average follow up period of 13.5 months and reported high incidence of complications related to the technique of tension band wiring. In five years restrospective study of twenty patients most frequent complication was symptomatic prominence of K. wire at elbow in 16 patients causing pain. There was skin breakdown in four patients and infection in one. Measurable proximal migration of K. wires however occurred in only three patients. Prominence of K. wires was usually due to improper seating (12 out of 16). According to them, complication of prominent K. wires can be

avoided by bending the proximal ends of wires 180° and carefully inserting them flush with cortex of proximal fragment. Proximal loop of tension band should be placed deep to triceps tendon.

Helm et al (1987) compared complications in 48 patients who had undergone internal fixation of displaced fracture of olecranon by either tension band (34 patients) or screwing (14 patients) with mean age of 44.6 years and 50.8 years and mean follow up 53.1 and 66 months respectively. Functional results after two years were equally good with both methods. In half of the cases in both groups, technique of fixation was poor. Adequate reduction was achieved in 70% cases of tension band group (even including 24 comminuted fractures) and in 50% of screwing group (including 11 comminuted fractures). Incidence of subsequent loss of reduction of fracture was considerably higher among those treated by screwing i.e. 9 out of 14 compared with 7 of the 34 fractures treated with tension band. Tension band technique was appreciably more reliable in maintaining reduction than screwing. According to them to avoid local complication of subcutaneous K. wires proximal ends of wires must be bent over and burried beneath triceps tendon. They enumerated complication in tension band group as wires were not parallel in 12 and in two cases they were so close that adequate rotational stability could not be achieved and in five wires were loose or too slender. In six cases ends were pround of bone.

PATELLA

Most significant effect of fracture patella are loss of continuity of extensor mechanisms of knee and potential incongruity of patellofemoral articulation.

Fracture of the patella may be classified as undisplaced or displaced and further subclassified as transverse involving upper or lower pole, oblique, vertical or comminuted. Undisplaced fractures may be treated non-operatively. Bostrom in his monogram on study of 416 patellar fractures considered 3 to 4 mm of separation and less than 2 to 3 mm of articular surface incongruity to be acceptable for non-operative treatment.

Since very beginning controversy is persisting regarding treatment of patellar fracture especially in reference to patellectomy.

A revolutionary idea was presented by Brook (1937). He concluded that patella is an integral part of skeleton phylogenetically inherited, and function plays no part either in its formation or its growth. In man it subserves no important function. It is a morphological remnant which is tending to undergo reduction and to disappear. It has become modified to take part in movements of knee joint but its presence is incidental and it is a deterrent rather than an aid to these movements. Experimental and other evidences have been advanced to show that in its absence the efficiency of knee joint is if any thing, increased, both as regard the rapidity of movements and power.

But Haxton (1945) expressed his opinion contradictory to Brook. He stated that any one who has removed patella can certify that patella actually gives attachment to most of the fibres of the quadriceps and patellar tendon and bone transmits tension produced by quadriceps. He demonstrated that power of extension increases as joint extends. In other words power of extension is greater with knee at 30° flexion than at 60, 90 or 120 degree. By comparing patients after patellectomy with normal people he showed that after patellectomy much of this increase in power as knee is extended is lost.

Herbert Kaufer et al (1971) by their experimental study demonstrated the functional utility of patella. According to them, patella contributes to knee extension movement through entire range of knee motion. In intact knee quadriceps movement arm increases with extension. At 120° patella accounted for 0.4 mm of movement arm, while at full extension contributes 1.8 cm. its action is like a pulley which displaces the quadriceps tendon anteriorly. Hereby increases movement arm. Its second action is to provide linkage between quadriceps tendon and patellar ligament. After patellectomy full extension requires between 15-30% increase in quadriceps pull. This is within reserve of quadriceps. So elderly person, patients with long standing intra-articular disease, muscle wasting disease and extension lag pior to

operation who cannot cope with this increased demand are likely to lose full active extension.

Mishra (1972) studied 30 cases of fracture patella treated by partial or total patellectomy. In this series 21 cases (70%) recovered excellent to good knee function, six were fair and only three had poor results. Out of these 16 patients felt that injured knee was as good as normal one. About 10 patients(33.33%) felt weakness. Eleven patients regained normal quadriceps girth but 19 had quadriceps wasting varying from 1/2 to 1" sixteen cases did show varying degree of ossification in quadriceps tendon, but only three out of these 16 showed degenerative changes in femoral condyles. According to him functional results of patellectomy are good and patellectomy does not adversely affect motion, strength or stability of knee.

Desai (1972) studied 40 cases of fracture of patella treated by total patellectomy(14), partial patellectomy(three), repair by sutures(11), and repair by wire (one). He observed quadriceps atrophy in 10 cases of patellectomy and in one case of repair, osteoarthritic change in four cases of patellectomy, feeling of weakness of knee in three and difficulty in climbing stair in three. He found early arthritic changes like pain, and crepitus in repair group. Restriction of movements was also highest in this group while they had stable and strong knee. He concluded that patellectomy in our country with oriental habits is treatment of choice. It does leave behind a

residual weakness but in our daily life a fully mobile knee will make a patient more happy than one which is strong, stable but has limited movements.

Fletcher S. Sutton et al (1976) evaluated 33 patients after patellectomy for subjective complaints objective physical finding including quadriceps strength and knee motion during daily activities. They studied thirty seven patellectomy(twenty six complete and eleven partial). Patients who had partial patellectomy had less pain with activity, could squat more easily; had fewer problems negotiating stairs and round ground and had a higher activity level than patients with complete patellectomy. Clinical instability occurred in four of eleven knees with partial patellectomy and in ninteen of twenty six complete patellectomy. Degree of instability was greater in knees with complete patellectomy.

Average range of motion for knee with partial patellectomy was $122^{\circ}$ and for those with complete patellectomy it was $117^{\circ}$ in comparison to $134^{\circ}$ in normal knee.

Quadriceps atrophy averaged 2.2 cm in knee with complete patellectomy and 0.8 cm in partial patellectomy. Quadriceps strength in knee with complete patellectomy averaged 49% reduction of strength of normal extensor mechanism and in partial patellectomy had gain of 5% compared to normal. Knee with complete patellectomy used less stancephase flexion (average $7^{\circ}$), less flexion going

up stairs(average 18$^{\circ}$) and less flexion going down stairs (mean 16$^{\circ}$). However patellectomised knees lost almost 50% of excursion in stance phase flexion(average 7$^{\circ}$). This is due to sinking of patellar tendon into inter-condylar notch and length of lever arm of extensor mechanism is reduced. This causes relative quadriceps insufficiency leading to inability to support the loaded flexed knee. This also explains the loss of flexion excursion seen when patellectomised knee is loaded and patient is going up and down stairs.

This reduction of lever arm (the perpendicular distance from applied force through extensor mechanism to centre of axis of rotation) mainly contributes to 49% reduction of quadriceps strength.

Observing complications of patellectomy various methods to reconstruct articular surface and fixing them by circumferential wiring, inter-fragmentary wiring, screws, pins and tension band wiring have been developed.

Weber et al (1980) studied efficacy of various forms of fixation of transverse fractures of patella by taking twenty twenty fresh cadaveric patellas. These were fractured transversely and fixed by four different techniques i.e. circumferential wiring, Magnuson wiring, tension band wiring and modified tension band wiring. These were mounted on machine capable of measuring quadriceps force, flexion angle, and fracture separation simultaneously with retinaculum repaired and not repaired.

Retinacular repair was found to contribute motility and this improved repair. In circumferential wiring fracture fragment separated progressively while the knee was extended from $90^\circ$ to approximately $30^\circ$ of flexion. This gap was only distraction. From $30^\circ$ to $0^\circ$ of flexion posterior angulation of fracture fragment was noted grossly. This angular deformity has its axis approximately in plane of circumferential wire.

Range of a measured displacement between individual specimen was wide. They concluded that results of circumferential wiring are highly variable.

With Magnuson wiring only small gap between fracture fragments was found and it increased only slightly through the range of motion. Repeated excursion from $90^\circ$ of flexion to extension and back to $90^\circ$ flexion did not led to further gross displacement and articular surface remained congruous.

In tension band wire technique entire of motion showed a consistent gap. With $90^\circ$ flexion and quadriceps relaxed articular surface was distracted by posterior angulation, but when quadriceps force applied and knee extended, posterior angulation with fracture gap diminished. Complete closure was observed at $60^\circ$ of flexion. Further motion of fracture fragments relative to each other was observed at $30^\circ$ and there was posterior angulation that progressively increased with extension.

In knees tested with modified tension band wiring no change in separation of articular surface was demonstrable.

Bostman et al (1981) studied 64 cases of comminuted, displaced fractures of patella. Out of these twenty one were treated with tension band wiring, thirty three by partial patellectomy and ten by total patellectomy. They classified comminuted patellar fractures in three types. Type I has latitudinal displacement of $<2$ mm longitudinal displacement, $<6$ mm and step or over riding $>2$ mm. Type II has latitudinal displacement $<2$ mm longitudinal $>6$ mm, while in type III latitudinal displacement was $>2$ mm and longitudinal $>6$ mm. Average age of patients was forty two years, in male thirty nine years and in females fifty one years. They followed patients for 8 months to 73 months. They also included 7 open fractures operated within 6 hours. Results of three different surgical techniques including tension band wiring are as follows

| <u>Technique</u> | Results | | |
|---|---|---|---|
| | Excellent | Good | Unsatisfactory |
| Tension band wiring(21) | 9 | 9 | 3 |
| Partial patellectomy(33) | 7 | 20 | 6 |
| Patellectomy (10) | 5 | - | 5 |

According to them partial excision showed satisfactory results provided that at least three fifths

of patella could be preserved. They found that a postoperative step of 1-2 mm did not seem to affect result in 3 cases.

They compared modest results reported by Nummo (1971), Bostorm (1972) and Sanderson (1974) after internal fixation. But in these series instead of anterior tension band wiring circumferential wiring was used. They reported good results in type I fractures and acceptable results were also achieved in several of more severe fractures. They concluded that even in type III anterior tension band wiring was superior to patellectomy.

They reported superficial wound infection in two, fibrous union in one and refracture after a definit second injury in one case treated by tension band wire fixation.

Dudani and Sancheti treated fifteen cases of fracture patella. Eighty percent of patients were in the age group of 20-50 years. Eleven patients had transverse fracture while four had comminuted fractures. All cases were operated within one to nine days of injury. Knee bending and quadriceps exercises and weight bearing with crutches were started from 11th to 14th day onwards.

They removed implants routinely six to nine months after surgery usually after radiological consolidation of fractures. At the end of two months excellent results were obtained in fourteen patients with knee

flexion more than 90$^{\circ}$ and quadriceps power grade 5. Out of these fourteen, nine had full knee flexion and remaining five 91 to 120$^{\circ}$. There was extensor lag in four cases which ultimately disappeared in six months time.

They found proximal migration of K. wires in one case and distal migration in another one and calcification in ligamentum patellae in one case after three months.

Le Vack et al (1985) retrospectively reviewed 64 patellar fractures treated either by internal fixation(30 cases) or by patellectomy (34 cases). Average follow up was 6.2 years with an age range of 19 to 99 years with mean age of 49 years. They reported good result in 60%, fair in 20% and poor results in 20% cases of patellectomy group. Osteosynthesis group showed 31% good result, 33% fair and 36% poor result. However, in osteosynthesis group two different techniques were used one was circumferential wiring carried in sixteen patients of whom only two had good result. Five had fair and nine had poor result. In other fourteen cases fixation by K. wires and anterior tension band wiring had been performed. Seven had good results, five fair and only two had poor results. They concluded that their results are in accord with Weber et al (1980) in which they found circumferential wiring was least effective as it gave poor fixation, limited patellar retinacular function and might interfere with blood supply of patella. According to study of Wilkinson (1977) they

concluded that upto 30% difference in quadriceps strength is not significant, 30-45% loss a moderate loss and over 45% a marked loss. No patient who had undergone osteosynthesis had lost more than 45% of quadriceps strength whereas nine of 34 thirty four patellectomies had done so and nine had moderate(30-45%) quadriceps strength loss.

After patellectomy patients with poor results typically complained of weakness and instability while those treated by osteosynthesis complained pain. Finally they concluded that after fracture of patella best results are obtained by accurate reduction and stable fixation probably by tension band wiring.

Hung et al (1985) treated 139 fractures of patella by tension band wiring but only 68 patients turned up in follow up. 61% patients were male. Their age ranged from 23 to 76 years. Types of fractures were transverse(53%), polar (27%), comminuted (18%) and vertical (2%).

Quadriceps exercises and knee movement were started within one week in 90% cases, walking started as soon as pain allowed and 80% patients succeeded to do so within two weeks.

Results were analysed by subjective and objective evaluation. Subjective evaluation was in terms of pain, weakness, stiffness and difficulty in kneeling and squatting. In this series 72% cases were in excellent-good

category. Objective evaluation was conducted for quadriceps girth, loss of flexion,lloss of extension and decrease in extensor power. Objective grading demonstrated 81.3% excellent to good results.

According to them rehabilitation of patients is simple and quick as 43% patients regained full movements within three months, another 43% did so in three to six months and remaining 14% in six to seven months.

They found two cases of deep infection, five of superficial infection and eight cases of delayed wound healing. Radiologically twenty two cases had poor reduction and 91% of whom had less than two mm displacement. They observed that 25% cases had broken wire loop, four were complicated by protrusion of wire and these took more than nine months after operation to manifest. They found chronic infection in one, loss of sensation in three and early osteoarthritis in 11 cases.

They concluded that imperfect reduction was due to poor operative technique rather than to defect in tension band because no progressive displacement was observed. Referring to Bostman (1982) they thought that accurate reduction must always be advocated and in simple transverse fractures vertical K. wires are capable of maintaining reduction.

Leung et al (1985) used percutaneous method of tension band wiring. They applied this technique for

undisplaced or slightly displaced closed fractures and fractures where the gap between the fragments was less than half cm. They applied figure of '8' loop with 8 mm wire placed across the front of fracture percutaneously through an 18 gauge long injection needle in crossed pattern. They treated five cases and found excellent results. Mobilisation of knee was started immediately.

Shrinivasalu et al (1986) studied fifty five cases of fracture patella. Of these forty comminuted fractures were treated by patellectomy and fifteen transverse fractures by open reduction and tension band wiring. Cases were operated within 24 hours. In post-operative period with tension band wiring, only compression bandage was applied for few days and as soon as patient could tolerate static quadriceps exercises active and assisted active knee flexion started.

In majority of patellectomy group, quadriceps wasting was present (82.5%) while in tension band group it was present only in 13.3% cases. Patellectomy group ended with excellent results in 17.5% and good results in 65% while tension band group had excellent results in 93.3% and good results in 6.7% of cases. They also reported extensor lag in few cases (17.5%) of patellectomy group. They concluded that in all fractures where anatomical reduction and stable fixation along with restoration of smooth articular cartilage is possible the patella should not be sacrificed.

Maini et al (1986) studied sixty cases of fracture patella excluding severely comminuted fractures where articular surface cannot be reconstructed. Out of these 39 were fixed by two K. wires and tension band wiring . 15 by circumferential loop and six by double tension band wiring.

Average age was 35.55 years ranging from 19 to 59 years. Active exercises were instituted between 10 to 14 days after stitches were removed. Straight leg raising could be done within an average period of 25.8 days ranging from 21 to 35 days. Partial weight bearing could be done within an average period of 30.55 days ranging from 28 to 40 days. Total weight bearing was allowed after fracture united clinically and radiologically. Average range of movement at knee at eight weeks was $100^{\circ}$ (range $90-120^{\circ}$) and at twelve weeks $115^{\circ}$ (range $90-135^{\circ}$)

They reported that quadriceps wasting improved with time as it was on an average 1.1.cm at 12 weeks but at two years follow up it was present only in two cases on an average of 1.5 cm. Superficial infection occurred in nine cases, local sensory deficit in three cases, painfull bursitis over prominent knots in six cases and fatigue fractures of wire was seen in four cases.

They graded results as excellent in 22, good in 23, fair in nine and poor in six cases.

FRACTURE MEDIAL MALLEOLUS

Medial malleolus may be involved in any one of six groups of injuries as described by Lauge Hansen. There may be transverse fracture in abduction injury or vertical fracture in adduction injury. In pronation external rotation injury there may be traction injury of medial malleolus. This fracture line characteristically slopes backward and downward. In supination external injuries and other injuries medial malleolus may be involved.

Conservative treatment of medial malleolar fracture by closed reduction and plaster immobilisation leads to disuse atrophy, osteoporosis, malunion and nonunion in about 10% of cases(Crenshaw). Non union may be due to fracture separation and inter-position of periosteum, extensor retinaculum or tibialis posterior tendon. Also being intra-articular fracture synovial fluid hampers union. Later on nonunion may lead to pain and xinstability of ankle.

Burwell and Charnelay (1965) studied one hundred thirty five cases of ankle fractures treated by open reduction and internal fixation and compared results of this series with results of 721 patients of ankle injuries treated conservatively. They referred to Lambotte (1907), Lane (1914), Lewis (1940), de Maneffe (1935) and Jergesen (1959) who said that fractures at ankle being intra-articular and in a weight bearing

extremity require accurate reduction if residual pain and disability are to be avoided and arthritis is to be reduced. In fractures of medial malleolus any displacement or angulation are expected to impair results. They found that solitary displaced fractures of medial malleolus cause difficulty regarding these factors and forward displacement must usually be accepted in closed method. They referred to Cox and Laxson, Michael and Fleming who mentioned regarding difficulty in maintaining the initial reduction. They observed that with uninterrupted immobilisation in conservative method after severe ankle injury traumatic exudate may organise so ankle movement may be restricted. When weight bearing is avoided for prolonged time osteoporosis may develop which may only resolve after many months and resolution may be incomplete in relatively inactive persons. Conservative treatment of medial malleolus definitely carries risk of nonunion due to interposition of periosteum and retinacular fibres (Muller, 1945). They referred to Coonard and Bugg (1954) who reported interposition of posterior tibial tendon. Magnuson (1949) considered incidence of nonunion of medial malleolus in conservatively treated fractures to be 10-15%.

They reported advantages of rigid internal fixation. First accurate reduction is usually achieve and maintained and secondly active exercises practised regularly prevent organisation of traumatic exudate which

otherwise may cause dense adhesions.

Muller et al recommended that if malleolar fracture fragments are small or osteoporotic they should be fixed by two K. wires and tension band wire. They recommended that these fractures should be fixed within 6-8 hours before blisters develop. If this time has passed fracture should be reduced first and immobilised in well padded plaster for 4-8 days and leg is kep elevated to reduce swelling. In order to prevent equinus deformity while the patient is still under anaesthesia the ankle is immobilised at $90^{\circ}$ by means of a double U plaster splint. Patient is encouraged to perform isometric exercises of foot and toe muscles and also to begin active dorsiflexion of ankle and toe. They said once painless movements are achieved and rest pain vanished plaster splint should be removed, that is usually between forth and tenth post operative days. They allowed weight bearing depending on severity of injury and stability of fixation. They immobilize only type C fractures for 4-5 weeks.

Denham (1974) studied 298 ankle fractures treated with open reduction and internal fixation of both malleoli. With early motion and avoiding plaster immobilisation results were highly satisfactory.

Beuchamp et al (1983) reviewed the treatment of 126 patients of ankle fracture. They showed that operative treatment obtains better fracture position. They observed

that in conservative group (55) anatomical reduction was achieved only in 11 and fair in 24 while in operative group (71) anatomical reduction was achieved in 48 and fair in 13 cases. They found complication in six cases of conservative group. Three patients developed plaster sore, two symptomatic nonunion and one sudecks atrophy. In operative group they noted complication in 36 cases, including marked inflammation, infection, persistent discharge, deep vein thrombosis, severe osteoporosis, requiring early metal removal. They concluded that internal fixation of ankle in women over 50 years is associated with high complication rates and that its benefits are limited.

Colton described that where manipulation fails to achieve anatomical reduction as is frequently the case, it must be assumed that there is soft tissue interposition between fragments consisting of deltoid ligament. In these conditions, they recommended open reduction and internal fixation either by screw or by traction - absorption technique of wiring described by Weber and Vasly.

Philips et al (1985) in their randomised study of 138 patients of grade IV external rotation injuries of ankle evaluated different methods of treatment. Ninty six patients with satisfactory initial closed reduction were randomised between continued closed treatment in a plaster cast and open reduction with rigid internal

fixation according to techniques of ASIF. Forty two patients with unsatisfactory closed reduction were randomised between open reduction with internal fixation of only the medial malleolus and open reduction with internal fixation according to ASIF techniques. They followed up 71 patients for an average of 3.5 years. In group of patients having initial satisfactory closed reduction followed by open reduction and internal fixation who had deltoid ligament tear gave better results than that of patients with medial malleolar fracture. Open treatment in comparison to closed treatment yielded better results in either of these medial side injuries and difference is significant statistically.

They concluded that patients with severe ankle fractures and satisfactory initial closed reduction had significantly better result after treatment by open reduction and internal fixation than after treatment by continued immobilisation in a plaster cast. They confirmed that patients with medial malleolar fractures and those who were more than 50 years old had worse prognosis and demonstrated that these did significantly better when treated by open methods. They expressed that ASIF technique emphasizes anatomical reduction and rigid internal fixation to allow early active motion. The early active motion provides advantage of pumping back edema fluid and decreasing swelling and which in turn

prevents or minimizes disuse atrophy of the muscles. This may minimize damage to articular cartilage by avoiding problems related to nutrition of cartilage in an immobilized joint and by preventing formation of intra-articular adhesions. They reported that open reduction with rigid internal fixation and early active motion appeared to be a more certain way of obtaining a good long term result.

# MATERIAL AND METHODS

# MATERIAL AND METHODS

This study "Evaluation of role of tension band wiring in various fractures" was conducted in the department of Orthopaedics, M.L.B. Medical College, Hospital, Jhansi. Suitable patients admitted through out patient department or emergency were included in the study. Patients were selected depending on clinical and radiological criteria irrespective of age and sex.

## CRITERIA FOR SELECTION OF CASES

All patients with simple fractures and also with grade I type of compound fractures were eligible candidates except the following :-

1. Compound injuries of type II and III.
2. Severely comminuted fractures where articular reassembling was not possible.
3. Where close reduction was satisfactory particularly in patients of medial malleolus fracture.
4. Patients with other associated vital injuries.
5. Severely debilitated and old patients.

## MANAGEMENT OF FRACTURE

After the admission patients were managed symptomatically. On travenous fluids analgesics and anti-inflammatory drugs along with rest to part of applying above elbow POP slab in fracture olecranon, cylinder slab

in case of patella with compression bandage in fresh cases and above or below knee posterior slab depending on associated injuries in cases of medial malleolus.

Patients were evaluated pre-operatively on following parameters :

1. General assessment of patients.
2. Local examination, specially for skin and other associated injuries.
3. Investigations - Routine
   - Specific
4. Radiological examination to study fracture anatomy.

Data regarding patient, procedure done and follow up were recorded as follows :

Name — Date of Admission

Age/Sex — Date of Injury

Clinical findings

Wound, if any

Associated injury

Ratiological finding

Type of fracture : Simple
: Comminuted
: Compound

Procedure done :

Date of operation

Post-operative X-ray findings :

Date of removal of external support :

Follow up : Condition of wound

Range of movement

Strength

Wasting

Complications

Result :

Instrument :

Apart from general surgical instruments following special instruments were required :

1. A.O. type wires tensioners for tightening of wire loop.
2. Wire cutter to cut Kirschner wire and wire loop.
3. Pair of pliers both general and pointed nose pliers.
4. A.O. type tension band wire and stainless steel wire gauge No. 18 and 20.
5. Kirschner wires of different caliber.
6. Special drill bits e.g. 2 mm and drill and T handle and mallet.

OPERATIVE PROCEDURE

In cases of fracture olecranon compbell's posterolateral approach was used. Fracture was exposed and freshened, reduced with due regard for articular reconstruction, rotatory and angulatory deformity. Reduction was maintained by towel clips. A coronal drill hole was made 1 cm distal to fracture and wire loop was passed through it and after that two parallel K. wire along posterior cortex of ulna were drilled through olecranon

process for about 3". Wire loop was fashioned in figure of eight over posterior surface of olecranon and around end of K wires and tightened. In two cases wire was passed anterior to triceps tendon. K. wires were bent 180° then rotated to 180° and hammered flush with bone surface.

In two cases olecranon screw were used as internal splint after overdrilling olecranon fragment and wire loop was passed around head of screws.

In one case of Monteggia fracture dislocation and olecranon fracture, ulnar nail in retrograde manner was used to fixed distal ulnar fracture and wire loop was passed around triceps tendon and the ulnar nail.

In fracture patella medial parapatellar approach was used in six cases, lateral parapatellar in one case and transverse approach in yet another.

Fracture was exposed, freshened and reduced with due care regarding articular congruity. Five to six mm from anterior surface of patella two drill holes were made at 20 mm distance from each other by using 2 mm drill bit. Then two 1.6 mm thick 6" long K. wires were passed from these holes proximally. Fragments were reduced and held with towel clips. The two K wires were then drilled into the distal fragment. 18 gauze wire loop was fashioned in figure of eight configuration on anterior surface of patella around prodruding ends of K. wires and tightened

Proximal ends of K. wires were bent 180° and rotated 180° and tucked in flush with bone. Distally wires were cut at about 1 cm distal to the distal part of patella. Medial and lateral retinacula were repaired and wound closed.

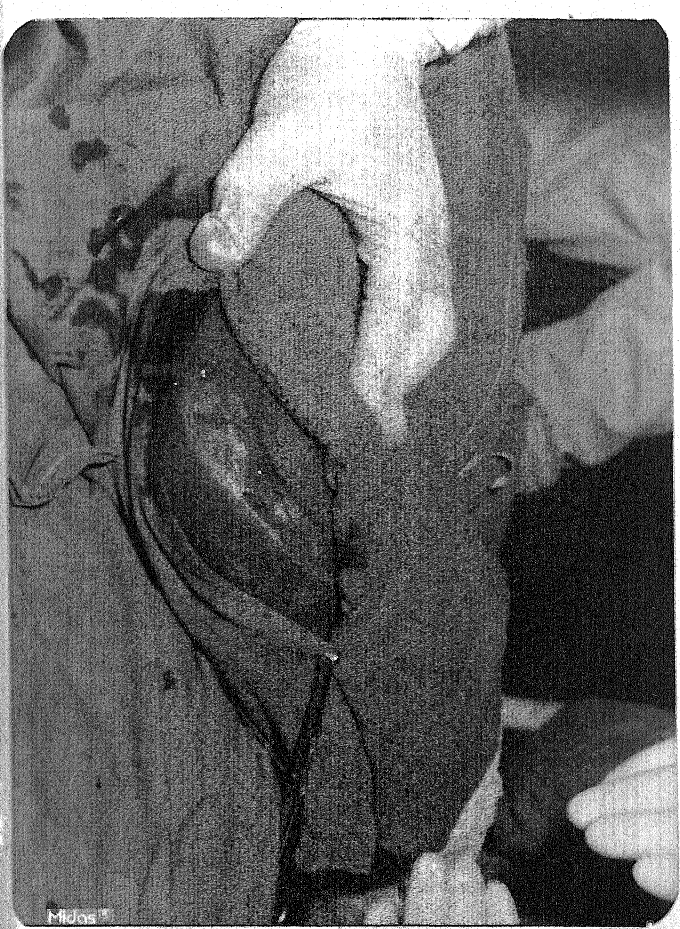
In patients of medial malleolus fracture, anteromedial approach was used. Fracture was exposed freshened and reduced. Reduction was held by towel clips. Transverse hole by 2 mm drill bit was made. 1.5 cm proximal to articular surface of tibia and wire passed through it. Then two K. wires 1.6 mm thick drilled from tip of malleolus anterolaterally for 4-5 cm. Wire loop was fashioned around K wires and tightened. K wires were bent 180° and tucked in to surface of bone after rotating 180°.

In two cases instead of K. wire Sherman's screws were used.

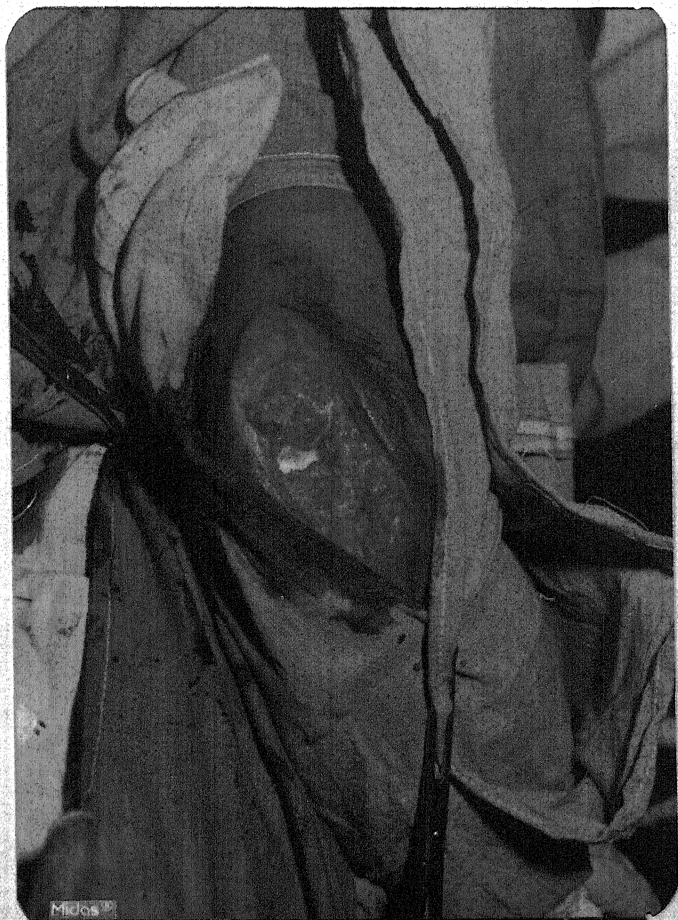
A compression bandage was applied and external support in form of above elbow POP slab cylinder slab or above knee POP cast or slab was used.

POST OPERATIVE MANAGEMENT

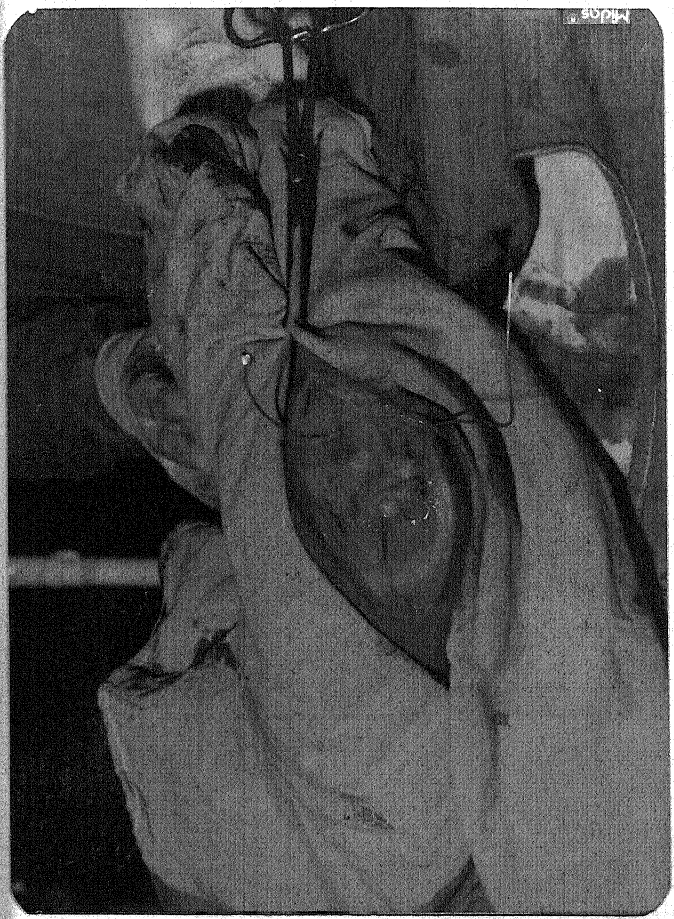
Postoperative check X-rays were taken to see reduction and efficiency of tension band loop. On an average of 4th day isometric quadriceps exercises were started in cases of patella. On average stitches were removed at 10th day in olecranon and at 12th day in patella



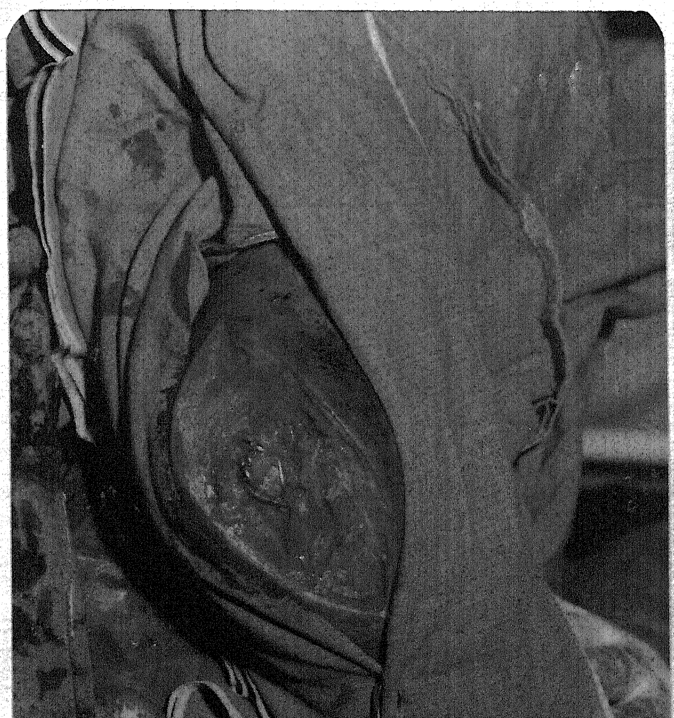
Campbell's posterolateral approach of elbow.



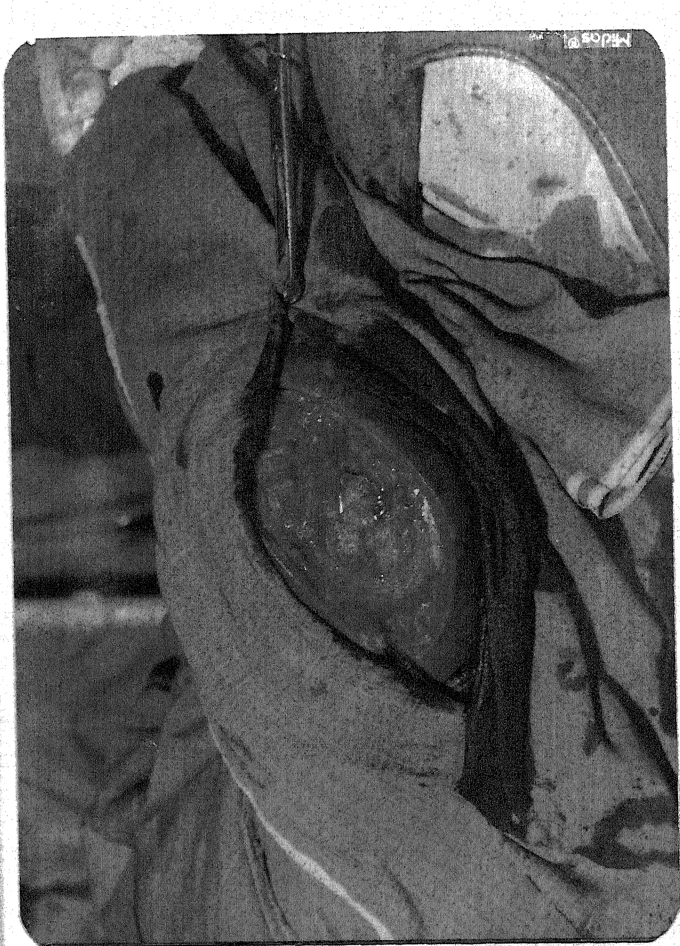
Fracture of olecranon process exposed.



Tension band wire passed through distal fragment and two K. wires passed from tip of olecranon in distal fragment.



Proximal ends of K wire bent $180^{o}$ and tension band wire tightened in figure of 8.



Bend ends of K wires rotated $180^{o}$ and tucked in bone.

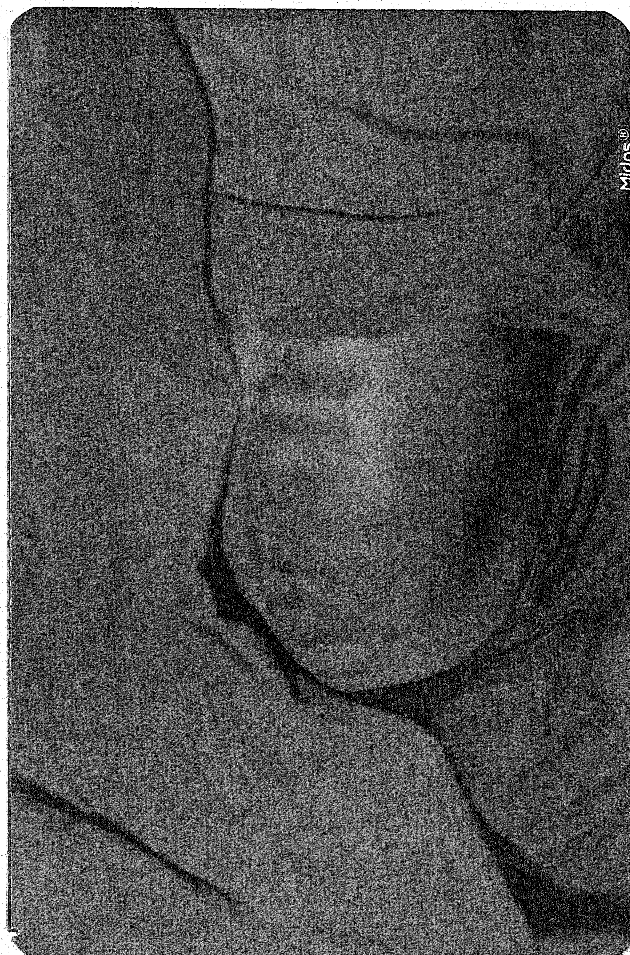
Wound closed.


Medial parapatellar approach knee. Fracture of patella exposed.


Two K wires passed from proximal into distal fragment of patella and tension band wire fashioned in figure of 8 on anterior surface of patella

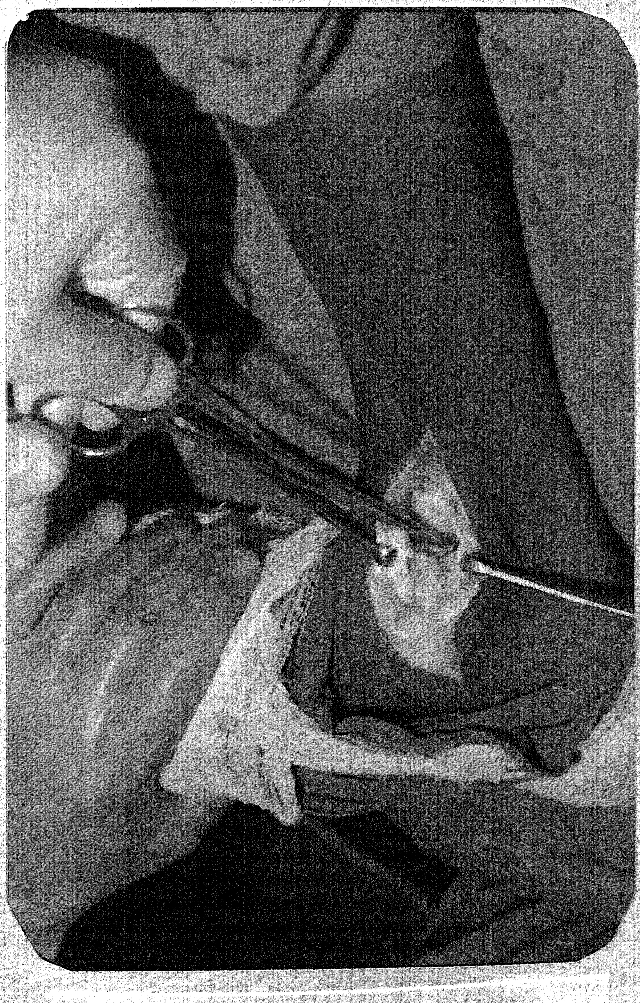

Tension band wire tightened and proximal ends of K wires bent 180°.


Bent ends of K wires rotated 180° and tucked in bone.



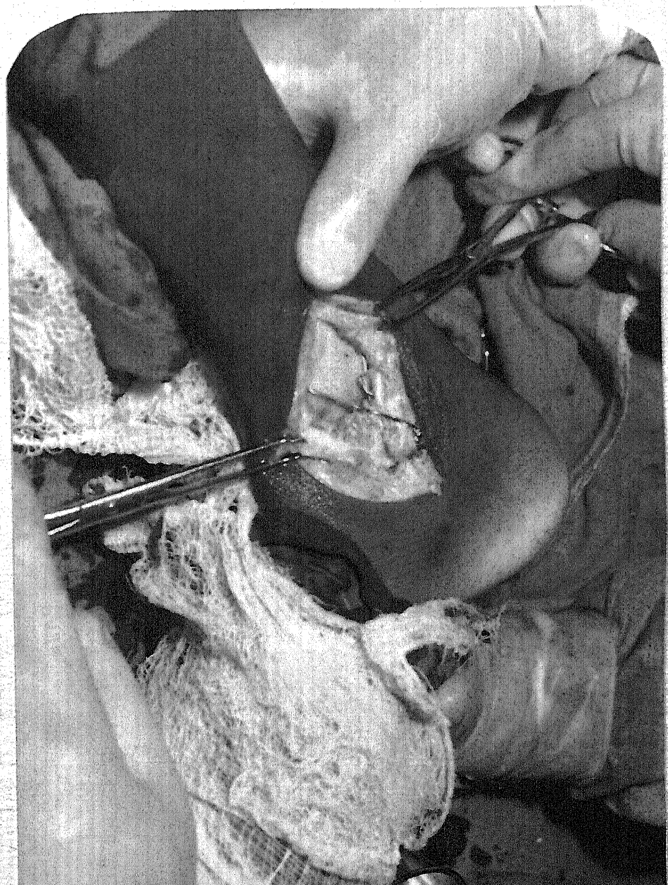
Wound closed.

Anteromedial approach of ankle.



Fracture of medial malleolus exposed.

Tension band wire passed from proximal fragment, and two K wires passed from tip malleolus into tibia.



Tension band wire tightened in figure of 8 K wires bent and tucked in bone.

Periosteum sutured over wire loop.

Skin sutured.

# O B S E R V A T I O N S

# OBSERVATIONS

In this study total of 26 cases of fracture olecranon, patella, and medial malleolus were treated by open reduction and tension band wiring in the department of Orthopaedics, M.L.B. Medical College, Hospital, Jhansi from July, 1989 to July, 1990.

## OLECRANON

### Age Incidence

Age of the patients varied from 10 to 59 years. Maximum number of cases were in age group ranging from 40 to 59 years. An average age of series was 37.4 years.

Table I : Showing the distribution of patients of fracture olecranon according to age.

| Sl. No. | Age group (years) | No.of cases | Percentage |
|---|---|---|---|
| 1. | 10-19 | 1 | 12.5 |
| 2. | 20-29 | 1 | 12.5 |
| 3. | 30-39 | 2 | 25.0 |
| 4. | 40-49 | 2 | 25.0 |
| 5. | 50-59 | 2 | 25.0 |
| | Total | 8 | 100.0 |

### Sex

In this series there were seven male cases and one female case.

## Mode of Injury

Table II : Showing mode of injury in olecranon process fracture.

| Sl. No. | Mode of Injury | No.of cases | Percentage |
|---|---|---|---|
| 1. | Raod Accident | 4 | 50.0 |
| 2. | Fall from height | 2 | 25.0 |
| 3. | Direct trauma | 2 | 25.0 |
| | Total | 8 | 100.0 |

## Classification of Injury

Table III : Showing types of injury.

| Sl. No. | Groups | Injury | No.of cases | Perce-ntage |
|---|---|---|---|---|
| 1. | I | Fracture with one fragment | 3 | 37.5 |
| 2. | II | Comminuted fracture without dislocation | 2 | 25.0 |
| 3. | III | Any fracture with associated radial head dislocation | 3 | 37.5 |
| 4. | IV | Open fracture | - | - |
| | Total | | 8 | 100.0 |

## Time Interval between Injury and Operation

Table IV : Showing the time interval between injury and operation.

| Sl. No. | Time Interval (days) | No.of cases | Percentage |
|---|---|---|---|
| 1. | 0 - 7 | 1 | 12.5 |
| 2. | 7 - 13 | 1 | 12.5 |
| 3. | 14 - 21 | 3 | 37.5 |
| 4. | $>21$ | 3 | 37.5 |

The average time interval was 19.6 days.

## Time Interval between Operation and post-operative mobilisation

Table V : Showing time interval between operation and postoperative mobilisation.

| Sl. No. | Post operative immobilisation (days) | No.of cases | Percentage |
|---|---|---|---|
| 1. | $<7$ | 2 | 25.0 |
| 2. | 8 - 14 | 3 | 37.5 |
| 3. | 15 - 21 | 1 | 12.5 |
| 4. | $>21$ | 2 | 25.0 |
| | Total | 8 | 100.0 |

## Symptomatic Grading

Patients were allocated a score on a four point scale depending upon symptoms as follows.

Table VI : Showing score depending on symptoms.

| Sl. No. | Points | Symtpoms | No.of cases | Percentage |
|---|---|---|---|---|
| 1. | 4 | No symptoms | 4 | 50.0 |
| 2. | 3 | Pain only, if tapped | 3 | 37.5 |
| 3. | 2 | Occasional, spontaneous pain | 1 | 12.5 |
| 4. | 1 | Frequent or constant pain | - | - |

## Range of Movements

Flexion and extension movements were recorded and compared with normal side and these were allocated on four point scale.

Table VII : Showing range of movement.

| Sl. No. | Follow up time (weeks) | Flexion range(degree) | | | Extension lack(degree) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 90-120 | 120-150 | >150 | 0 | 5 | 10 | 15 | 20 | 30 |
| 1. | 4 | 3(6) | 3(6) | - | - | - | 4 (6) | - | 1 (6) | 1 (6) |
| 2. | 8 | 2(7) | 5(7) | - | 3 (7) | 1 (7) | 2 (7) | - | - | 1 (7) |
| 3. | 24 | 1(4) | - | 3(4) | 3 (4) | - | - | - | 1 (4) | - |
| 4. | 32 & onwards | - | - | 2(2) | 2 (2) | - | - | - | - | - |

Figures in paranthesés indicate total number of patients in question at that time.

Table VIII : Showing scoring depending on range of movement.

| Sl. No. | Points | Category | No.of cases | Percentage |
|---|---|---|---|---|
| 1. | 4 | Normal : symmetrical range | 5 | 62.5 |
| 2. | 3 | Excellent : Upto $10^{\circ}$ loss | - | - |
| 3. | 2 | Good : Upto $30^{\circ}$ loss | 1 | 12.5 |
| 4. | 1 | Poor : more than $30^{\circ}$ loss | 2 | 25.0 |

Strength of Elbow Extension

Strength of elbow extension was compared to other normal elbow and graded as follows.

Table IX : Showing extensor strength at end of follow up.

| Sl. No. | Points | Category | No.of cases | Percentage |
|---|---|---|---|---|
| 1. | 4 | Normal | 6 | 75.0 |
| 2. | 3 | Satisfactory | 2 | 25.0 |
| 3. | 2 | Poor | - | - |
| 4. | 1 | Very poor | - | - |

Table X : Showing extensor strength at different period.

| Sl. No. | Period of follow up (weeks) | Strength | | | |
|---|---|---|---|---|---|
| | | Normal | Satisfactory | Poor | Very poor |
| 1. | 4 | 5(6) | 1(6) | - | - |
| 2. | 8 | 5(7) | 1(7) | 1(7) | - |
| 3. | 24 | 3(4) | 1(4) | - | - |
| 4. | 32 | 2(2) | - | - | - |

Figures in parantheses indicate total number of patients in question.

## Radiological Assessment

Accuracy of reduction was assessed on first post-operative check radiograph and was scored as follows :

Table XI : Showing accuracy of reduction.

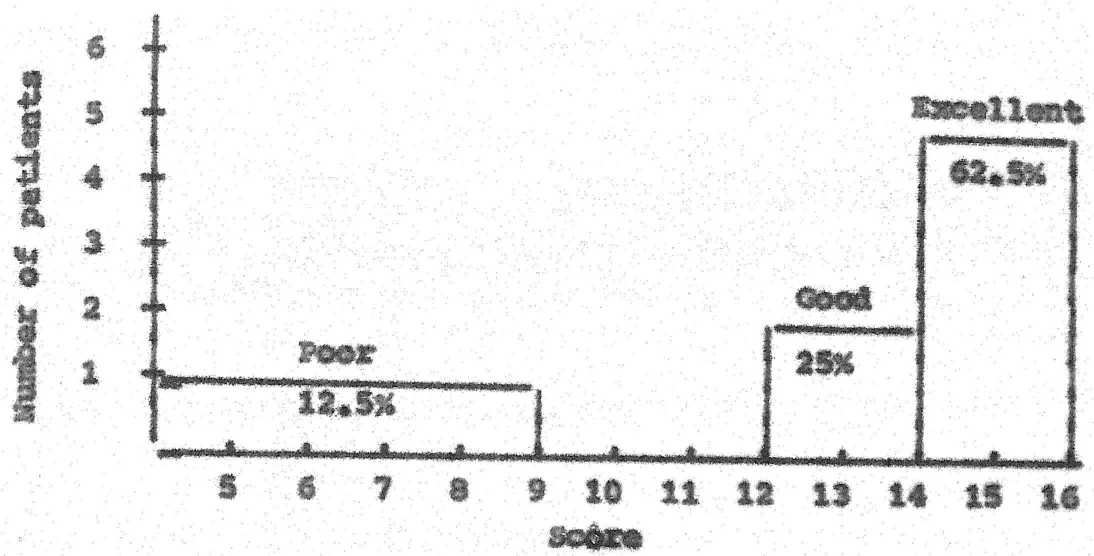
| Sl. No. | Points | Category | No.of cases | Percentage |
|---|---|---|---|---|
| 1. | 4 | Excellent : Fracture barely visible | 5 | 62.5 |
| 2. | 3 | Satisfactory : Fracture obvious but without step at articular surface. | 2 | 25.0 |
| 3. | 2 | Fair : A step of upto 2 mm persisted at articular surface. | 1 | 12.5 |
| 4. | 1 | Poor : A residual step of more than 2 mm. | - | - |

## Results

Results were categorised after adding score for four criteria e.g. symptoms, range of movement, extensor strength and accuracy of reduction. Maximum four was allocated to each. Patients having score of 14-16 were categorised as excellent, 12-14 as good and less than 12 as poor. Scoring criteria was advocated by Holdsworth et al.

Table XII : Showing results.

| Sl. No. | Points | Category | No.of cases | Percentage |
|---|---|---|---|---|
| 1. | 14 - 16 | Excellent | 5 | 62.5 |
| 2. | 12 - 14 | Good | 2 | 25.0 |
| 3. | $\angle$ 12 | Poor | 1 | 12.5 |




(Graphic representation of results)

Complications

We found small number of complications in this series. These are pain, if tapped over olecranon in three, painful bursitis over end of wire loop in one case in which later on end of wire loop protruded out of skin stiffness of elbow in same case of bursitis and superficial infection in one case.

## PATELLA

Age Incidence

In present study, the age of the patients was between 25 to 55 years with an average age of 36.2 years.

Sex

All patients were males.

Mode of Injury

Causes of injury were classified simply into three subgroups as given in table XIII.

Table XIII : Showing the mode of injury.

| Sl. No. | Mode of injury | No. of cases | Percentage |
|---|---|---|---|
| 1. | Direct trauma | 1 | 12.5 |
| 2. | Fall from height | 5 | 62.5 |
| 3. | Road accident | 2 | 25.0 |

Type of Injury

Injury was subtyped into simple, compound and according to radiological finding into transverse comminuted and polar.

Table XIV : Showing the types of injury.

| Sl. No. | Type of injury | No. of cases | Percentage |
|---|---|---|---|
| 1. | Simple | 7 | 87.50 |
| 2. | Compound : Grade I | 1 | 12.50 |
| | : Grade II | | |
| | : Grade III | | |

Table XV : Showing radiological classification of injury.

| Sl. No. | Radiological type of injury | No. of cases | Percentage |
|---|---|---|---|
| 1. | Transverse | 4 | 50.00 |
| | Polar : | | |
| 2. | a. Through upper pole | 1 | 12.50 |
| | b. Through lower pole | 1 | 12.50 |
| 3. | Comminuted | 2 | 25.00 |

Time Interval between Injury and Operation

This was within 7 days in two cases, between 7 to 14 days in three cases and between 15-21 days in one case and more than 21 days in two cases. An average time interval was 16.4 days.

Postoperative Radiological Assessment

Post operative X-ray demonstrated good reduction in 6 cases, poor reduction in 2 cases.

Time Interval between operation and Post-operative Mobilisation

Isometric knee exercises were started from 4th to 6th day as pain permitted. Active knee motion was started at 10th day in 6 cases and after three weeks in cases where there was extensive extensor expansion damage accounting for two cases. An average time of post operative immobilisation was 15.5 days.

Knee Movements

Knee movements were recorded by measuring flexion movement from neutral position and also extension lag was measured. This range of movement is shown in table XVI.

Table XVI : Showing flexion movement of knee.

| Sl. No. | Follow up (weeks) | Knee flexion range (degree) | | |
|---|---|---|---|---|
| | | ∠ 90 | 90-120 | 120-135 |
| 1. | 4 | 3(8) | 4(8) | 1(8) |
| 2. | 8 | 2(8) | 4(8) | 2(8) |
| 3. | 16 | 1(6) | 2(6) | 3(6) |
| 4. | 24 & onwards | 1(5) | 1(5) | 3(5) |

Figures in paranthesis indicate number of patients in question at that time.

Table XVII : Showing extensor lag.

| Sl. No. | Follow up (weeks) | Extension lag (degree) | | | |
|---|---|---|---|---|---|
| | | 0-5 | 6-10 | 11-20 | > 20 |
| 1. | 4 | 4(8) | 2(8) | 1(8) | 1(8) |
| 2. | 8 | 5(8) | 2(8) | 1(8) | - |
| 3. | 16 | 5(6) | - | 1(6) | - |
| 4. | 24 & onwards | 4(5) | - | 1(5) | - |

Figures in parantheses indicate total number of patients in question at that time.

Quadriceps Wasting

Quadriceps girth was measured at 10 cm proximal to patella. There was no significant quadriceps wasting. It was recorded by measuring difference in girth of two thighs. It was as given below.

Table XVIII : Showing quadriceps girth (Quadriceps).

| Sl. No. | Follow up (weeks) | Quadriceps girth difference (mm) | | |
|---|---|---|---|---|
| | | $<12$ | 12-25 | $>25$ |
| 1. | 4 | 5(8) | 2(8) | 1(8) |
| 2. | 8 | 6(8) | 1(8) | 1(8) |
| 3. | 16 | 5(6) | - | 1(6) |
| 4. | 24 | 4(5) | - | 1(5) |

Figures in parantheses indicate total number of patients in question at that time.

## Knee Extension power

Power of knee extension was compared with normal knee.

Table XIX : Showing knee extension power.

| Sl. No. | Follow up (weeks) | Extension power grade | | | |
|---|---|---|---|---|---|
| | | V | IV | III | $<$ III |
| 1. | 4 | 4(8) | 2(8) | 2(8) | - |
| 2. | 8 | 5(8) | 2(8) | 1(8) | - |
| 3. | 16 | 5(6) | 1(6) | - | - |
| 4. | 24 | 4(5) | 1(5) | - | - |

Figures in parantheses indicate total number of patients in question at that time.

## Weight bearing

Time at which weight bearing was allowed is shown in table XX.

Table XX : Showing period of weight bearing.

| Sl. No. | Postoperative days at which weight bearing became possible | Partial weight bearing | | Full weight bearing |
|---|---|---|---|---|
| | | No. of cases | Percentage | |
| 1. | Upto 7 | - | - | - |
| 2. | 7 - 14 | 6 | 75 | Full weight bearing was allowed after union |
| 3. | 15 - 21 | - | - | - |
| 4. | > 21 | 2 | 25 | - |

An average period at which partial weight bearing became possible was 24 days.

## Postoperative Reduction

Postoperative reduction quality is shown in following table XXI.

Table XXI : Showing postoperative reduction.

| Sl. No. | Category | No. of cases | Percentage |
|---|---|---|---|
| 1. | No step in articular surface | 3 | 37.50 |
| 2. | Step of 1-2 mm | 4 | 50.00 |
| 3. | Step > 2 mm | 1 | 12.50 |

## Subjective Analysis

Patients were analysed mainly regarding pain and functional disability. It is recorded whether patients have constant pain, pain on special occasion or with weather changes.

Table XXII : Showing incidence of pain at the end of follow up.

| Sl. No. | Status of activity | No.of cases | Perce-ntage |
|---|---|---|---|
| 1. | Constant pain | 1 | 12.50 |
| 2. | Pain after heavy work | 2 | 25.00 |
| 3. | Pain with weather change | - | - |
| 4. | Pain during climbing stairs | 1 | 12.50 |
| 5. | No pain | 4 | 50.00 |

## Results

Anatomical and functional results were categorised according to Reich and Rosenberg (1945) as follows :

### Excellent

No pain or occasional pain after exceptionally heavy work, range of motion equal to uninvolved side.

### Good

In which pain occurs with weather changes or on prolonged activity and limitation of last 10-20 degrees of flexion. There may be osteoporosis of patella in varying degree.

### Fair

In this, pain occurs during climbin stairs or during heavy work, range of flexion more than 75 degrees.

**Poor** : In this category motion is less than 75 degree with constant pain, thigh atrophy more than 2.5 cm.

Results of this series were as follows :

Table XXIII : Showing results of the series.

| Sl. No. | Results | No.of cases | Percentage |
|---|---|---|---|
| 1. | Excellent | 4 | 50.00 |
| 2. | Good | 1 | 12.50 |
| 3. | Fair | 2 | 25.00 |
| 4. | Poor | 1 | 12.50 |

Complications

Complications were recorded as effusion in one case, protrusion of end of wire loop in same case of effusion and broken wire loop in one case.

Table XXIV : Showing complications.

| Sl. No. | Complications | No.of cases | Percentage |
|---|---|---|---|
| 1. | Effusion in knee joint | 1 | 12.50 |
| 2. | Protrusion of end of wire loop | 1 | 12.50 |
| 3. | Broken wire loop | 1 | 12.50 |
| 4. | Infection - superficial | 1 | 12.50 |
| | - deep infection | - | - |

MEDIAL MALLEOLUS

Medial malleolus was fixed by two K. wires or Sherman screw along with a figure of eight wire loop. Different parameters were recorded as follows.

Age Incidence

Age distribution is shown in table 25. An average age was 32.6 years.

Table XXV : Showing age distribution of cases.

| Age group (years) | No.of cases | Percentage |
|---|---|---|
| 10 - 19 | 2 | 20.00 |
| 20 - 29 | 3 | 30.00 |
| 30 - 39 | 2 | 20.00 |
| 40.4 49 | 1 | 10.00 |
| 50 - 59 | 2 | 20.00 |
| Total | 10 | 100.00 |

Sex Incidence

All cases were male.

Mode of Injury

Mode of injury was fall from height in four, road accident in four and by twisting of foot during walking in two cases.

Associated Injuries

Associated injuries were central fracture dislocation hip in one case, Cole's fracture in one and fracture of lateral malleolus or fibula in six cases.

Types of Injury

Injury around ankle was studied and classified according to classification of Lauga Hensen as follows.

Table XXVI : Showing type of injury

| Sl. No. | Type of injury | No.of cases | Associated ankle injury alongwith fracture of medial malleolus |
|---|---|---|---|
| 1. | Adduction | 2 | Transverse fracture of lateral malleoli at joint level. |
| 2. | Abduction | 6 | In four cases tear of lateral ankle ligament and two comminuted fracture of fibula |
| 3. | Pronation : External rotation type. | 2 | Fracture of fibula lower end. |

Time Interval between Injury and Operation

Time between injury and operation was within 7 days in four cases, between 8 to 14 days in five cases and after 17 days in one case with an average of nine days.

Post Operative Radiological Evaluation

Radiological criteria of reduction was adopted for medial malleolus according to Magnuson (1949) and Klossner (1962). These are :

Anatomical : No medial or lateral displacement.
No angulation, no talus displacement.

Fair : No medial or lateral displacement. No angulation and 2.5 mm posterior displacement of lateral malleolus.

Poor : Any medial or lateral displacement, more than 5 mm posterior displacement and any residual displacement of talus.

In this series anatomical reduction was achieved in four cases and fair in rest six cases.

Table XXVII : Showing radiological grading of reduction.

| Sl. No. | Category | No.of cases | Percentage |
|---|---|---|---|
| 1. | Anatomical | 4 | 40.00 |
| 2. | Fair | 6 | 60.00 |
| 3. | Poor | - | - |

## Post operative Mobilisation

In all cases active toe movements were encouraged as soon as pain tolerance permitted. Patients with fracture of medial malleolus only(4) were allowed to do active ankle and subtalar movements at 5th day. This active movement and strategy was also followed in other two cases in whom fibula was also fixed internally.

## Post operative Plaster Immobilisation

No immobilisation was done in case of fracture of medial malleoli only. In other cases were kept immobilised for 6 weeks.

## Weight bearing

Partial weight bearing was allowed as soon as pain permitted for initial six weeks and unsupported weight bearing was permitted after union.

Subjective Assessment

Patients were questioned about pain, disability in walking and data recorded are given in the table XXVIII.

Objective Assessment

Patients were assessed for ankle movements and gait as given in table XXIX.

CLINICAL EVALUATION

A. Objective Criteria

Criteria used were according to those of Magnuson and Knossner. These were categorised as :

Good : with ankle and foot movements at least three fourths normal, trivial swelling and normal gait.

Fair : with ankle and foot movements at least half of normal.

Poor : with ankle and foot movements less than half normal, swelling, visible deformity of ankle or foot and limp.

B. Subjective Assessment : is graded as -

Good : for cases with complete recovery apart from slight aching after use.

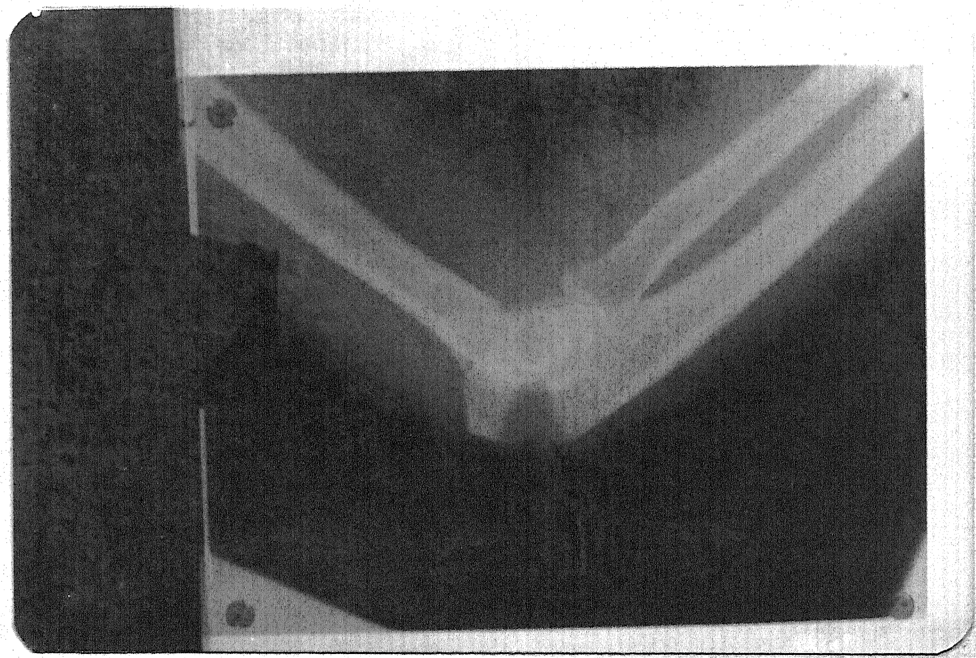
Fair. : with aching during use, slight disability(not enough to interfere with work) ability to walk not seriously impaired.

Poor : with impairement of ability to work, walk or pain.

Table XXVIII : Showing subjective data.

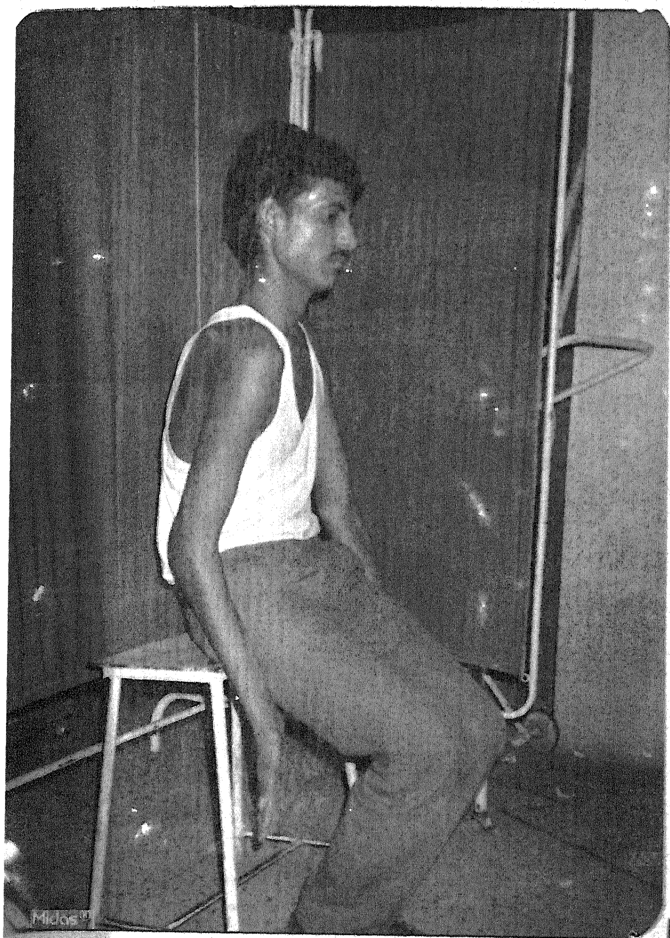
| Sl. No. | Follow up (weeks) | No pain | Aching after use | Slight disability to walk | Walking impaired | Resistant pain |
|---|---|---|---|---|---|---|
| 1. | 4 | 5(10) | 5(10) | 3(10) | - | - |
| 2. | 8 | 6(10) | 4(10) | 2(10) | - | - |
| 3. | 12 | 7(9) | 2(9) | 1(9) | - | - |
| 4. | 24 | 5(7) | 2(7) | 1(7) | - | - |

Figures in parentheses indicate number of patients in question at thattime.

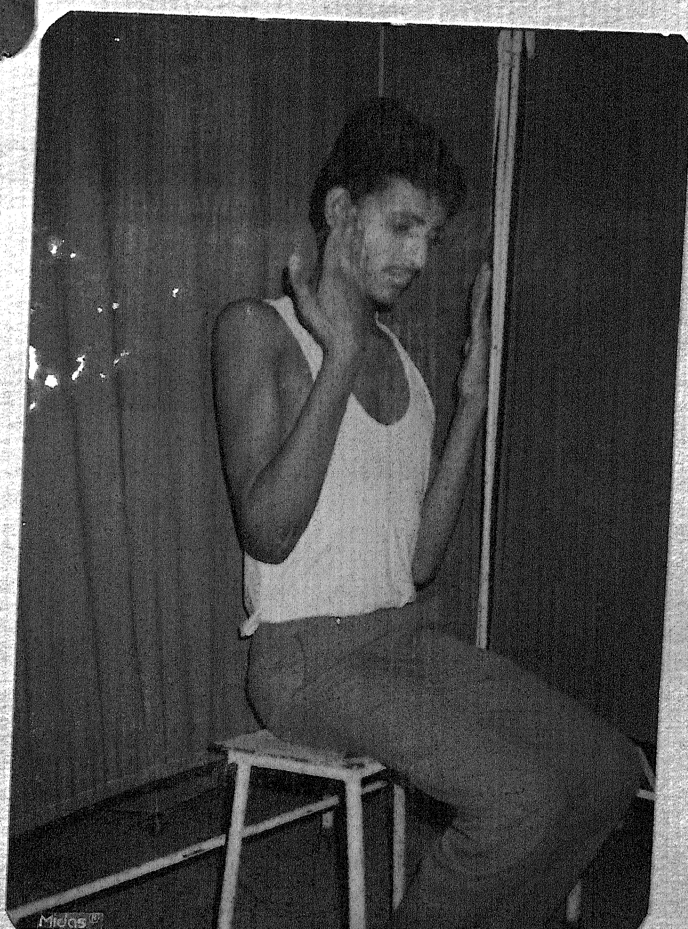


Lateral view Elbow showing Transverse fracture of olecranon process.

A.P. and lateral view elbow showing tension band wire fixation.

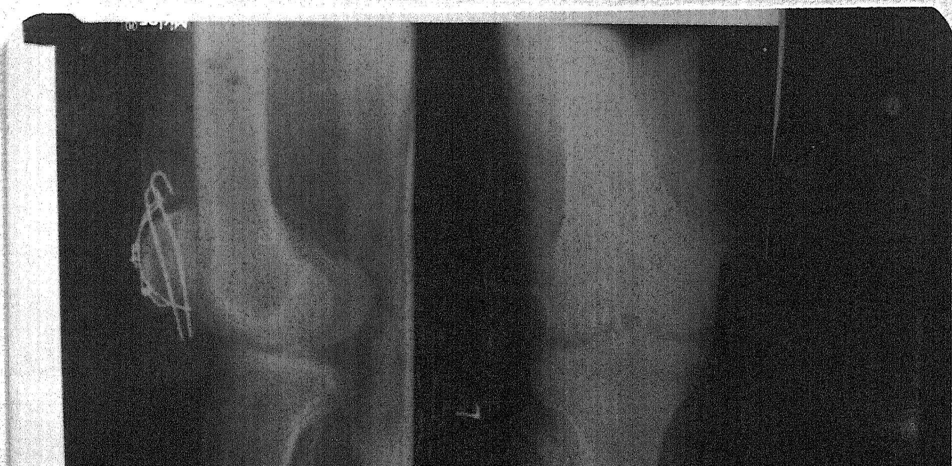


Photograph : two weeks after operation showing elbow extension.

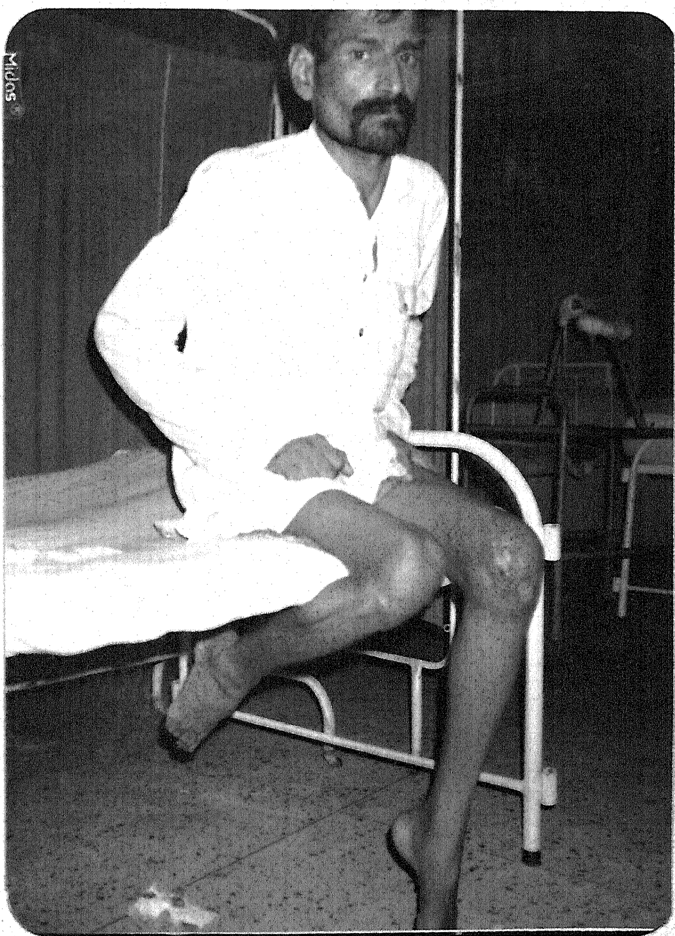


Photograph two weeks after operation showing elbow flexion.

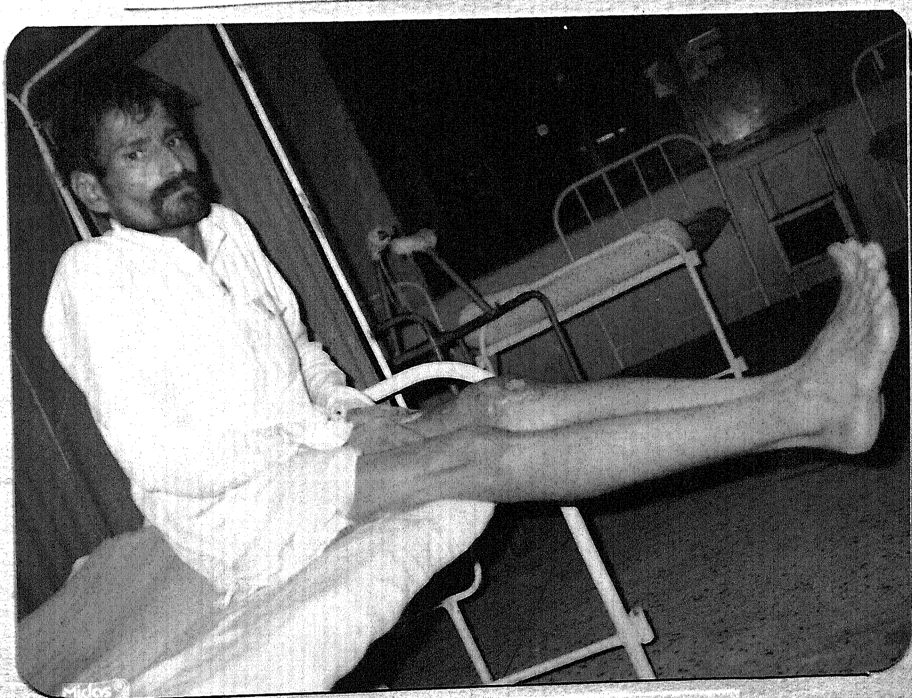
PA and lateral view knee
showing fracture patella.



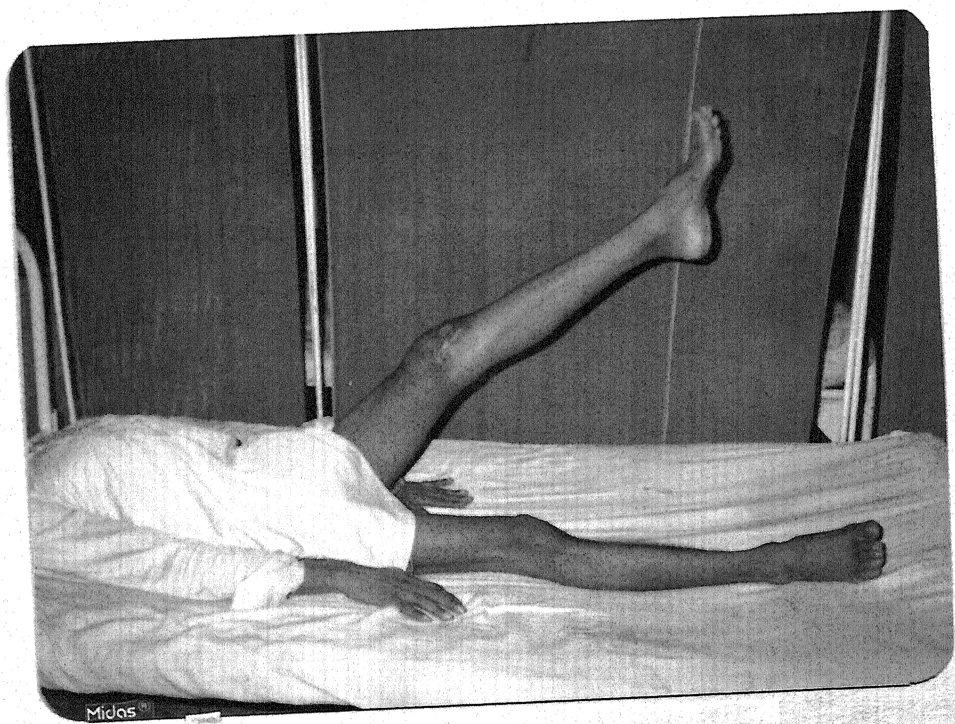
PA and lateral view showing
tension band wire fixation
of patella.



Photograph two weeks after operation showing knee flexion.

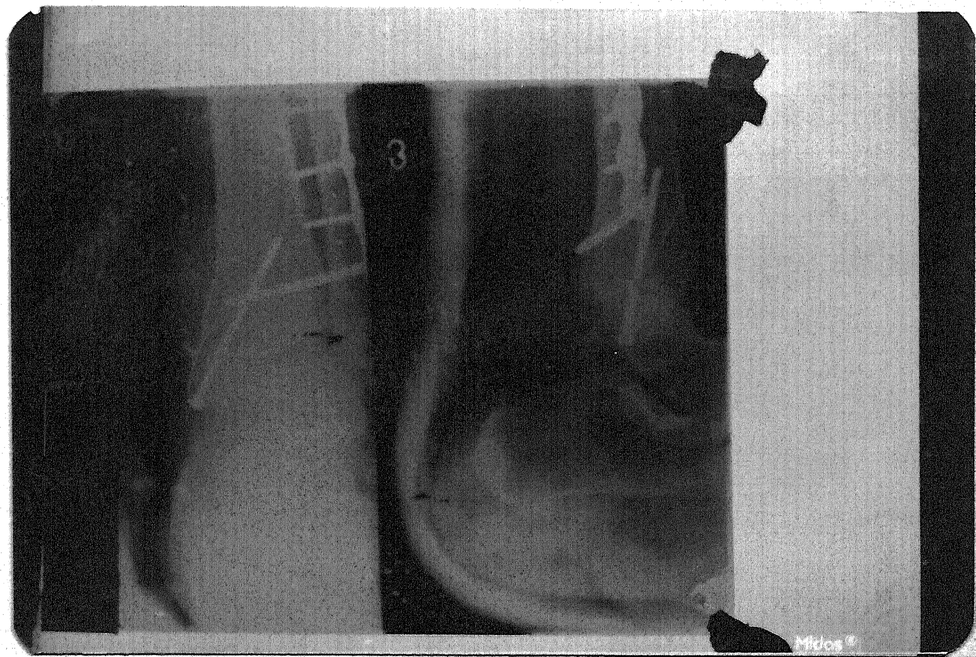


Photograph two weeks after operation showing knee extension.



Photograph 'two weeks after operation showing straight leg raising.

AP and lateral view ankle showing fracture of medial malleolus and lower end of fibula.



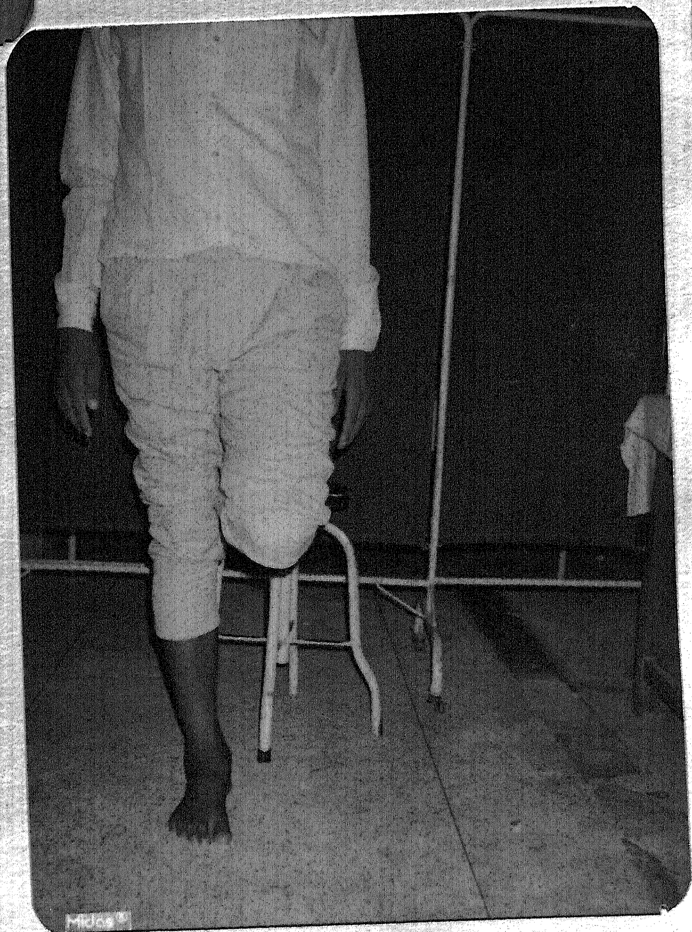
AP and lateral view ankle
6 weeks after operation showing
tension band fixation of medial
malleolus and sherman's plate
fixation of fibula.

AP and lateral view ankle
of same patient after 6
months showing good union.

Photograph of same patient after 3 months showing ankle dorsiflexion.

Photograph after 3 months showing foot inversion.

Photograph showing weight bearing on both forefeet.



Photograph after 3 month showing weight bearing on operated foot.

AP-lateral view ankle showing fracture medial malleolus.

AP-lateral wiew showing tension band wire fixation of medial malleolus.

# D I S C U S S I O N

# DISCUSSION

The aim of fracture treatment is restoration of normal anatomy and function at the earliest possible. Fractures of olecranon, patella and medial malleolus being intraarticular, normal anatomical relationship should be achieved to avoid complication of joint derangement, stiffness, wasting, osteoporosis. To achieve this tension band wiring technique has been applied for these fractures using the principle of dynamic compression in which distraction forces are converted into compression forces by surface wire. Mobility provided by this technique avoids development of fracture disease.

In this series fractures of olecranon, patella and medial malleolus were treated by tension band wiring and different parameters were compared with those shown by other studies.

## OLECRANON

In this study eight fractures of olecranon process were treated by tension band wiring and their results compared with others. Patients were mainly within age group of 40-59 years with average age of 37.4 years. Seven patients were male and one was female which may be due to overactivity of male population.

Pandit et al (1986) treated 20 cases of olecranon process fracture by tension band wiring technique. There were 16 male and four female cases.

Maini et al (1986) treated 39 fractures of olecranon process in a study of rigid fixation of various fractures by tension band wiring. There were 24 male and 15 female patients with average age of 31.6 years.

Holds Worth et al (1984) conducted a study of elbow function following tension band fixation of displaced fractures of olecranon. In that series there were 52 cases including 28 male and 24 female. Patients were mainly between two age groups i.e. 10-25 and 55-70 years.

In present series, four cases(50%) were caused by road accident, two(25%) by fall from height and two (25%) were caused by direct trauma over point of elbow. This preponderance of road accident may be due to improper traffic rules and regulations and their even poorer enforcement.

Holdsworth et al (1984) in their series of 52 cases found that 25 cases were due to fall and 19 cases due to road accident.

Pandit et al (1986) in their study of 20 cases, contrary to present series, found that only three cases were caused by road accidents. Majority i.e. 13 cases were due to fall and four due to direct trauma.

In this series there were three cases of group I injury, two of group II and three of group III injury. All fractures were simple.

In study of Holdsworth et al (1984) there were 25 cases of group I injury, 11 of group II, 10 cases of group III and two cases were compound i.e. of group IV injury.

In study of Pandit et al (1986) when cases were re-arranged according to Holdsworth classification there were 16 cases of group I, one of group II and three of group III injury. Similarly study of Maini et al (1986) found 21 cases of group I and 18 cases of group II injury in total of 39 cases.

In present study time interval between injury and operation on an average was 19.6 days. This time lag is because firstly patients came late and secondly facilities for investigation and surgical treatment were not immediately available and in some cases condition of skin and associated injuries delayed surgery.

Holdsworth et al (1989) in their series operated selected cases within 48 hours.

In study of Pandit et al (1986) the time interval was 72 hours. In other study conducted by Maini et al (1986) this time interval was 20.15 days.

In this present study time interval between operation and post-operative mobilization was within

first week in two, within 8-14 days in three, at three weeks in one and after three weeks in two cases. This delay in removing post operative splint is due to associated dislocation of head radius in one case in which splint was removed at 3 weeks. In other case there was associated fracture head radius and also fracture of shaft ulna in which splint was removed after union of fracture shaft ulna. In other two cases delay was due to comminution where fixation was not sufficient to allow early mobilization.

Holdsworth et al (1984) did not apply any external splint and used to encourage active movements after 48 hours.

Mathwson in his series mobilised elbow after one to two weeks. Pandit et al mobilised elbow as pain subsided.

In present study flexion and extension movements were recorded at different followup period. flexion movement at four weeks was in range of 90-120$^{\circ}$ in three and 120-150$^{\circ}$ in three cases. Extension lag at this period was 10$^{\circ}$ in four cases, 20$^{\circ}$ in one and 30$^{\circ}$ in one case. Movements improved with time. At six months flexion movement was in range of 90-120$^{\circ}$ in only one(25%) case and over 150$^{\circ}$ in three(75%) out of four available patients for follow up. Similarly extension movement improved and at six months there was no extension lag in three(75%) and lag of 20$^{\circ}$ in only one(25%) case.

This limitation of flexion and extension in one case was due to nonco-operative nature of patient as he did not follow instructions regarding physio-therapy. Secondly there might be some element of pain preventing him from active movements as he had mild painful bursitis over end of figure of eight wire loop.

Holdsworth et al(1984) in their study reported full flexion movement in 39(75%) and loss of 5° flexion in two, loss of 10° in eight, loss of 15° in two and loss of 20° in only one case. They also reported full extension in 22(42.3%) cases and loss of 5° in four, 10° in 13, 15° in 4, 20° in four and over 30° in five cases.

Pandit et al (1986) reported full flexion movements in 15(75%) cases and also full extension movement in 15. There was limitation of last 20° extension movement in five (25%) of total 20 cases.

Maini et al (1984) observed movements in their series of 39 cases and found flexion range of 90-120° in three, 120-150° in 10 and over 150° in 26 cases. They found full extension in 25 and extension lag of 5° in 11, 10° in one and 15° in two cases.

So our results regarding movement were nearly in accord with series of Pandit, Maini and Holdsworth et al.

In our study extensor strength was normal in six and satisfactory in two cases.

Holdsworth et al (1989) reported extensor strength as normal in 19, satisfactory in 20, poor in seven and very weak in four cases.

Pandit et al reported normal extensor power in 15 and mild weakness in five of 20 cases.

Post-operative radiological assessment in our present study showed excellent reduction of fracture in five, satisfactory in two and fair in one case.

While Holdsworth et al (1989) reported excellent reduction in 33, satisfactory in 14, fair in three and poor in two cases of their series.

Thus quality of our postoperative reduction was in accordance with that of Holdsworth.

In present series, we found pain three patients if tapped over olecranon. Painful bursitis over end of wire loop dewaloped in one patient in which later on end of wire loop protruded out of skin necessitating removal of tension band. In same case there was stiffness of elbow and mild weakness of triceps. In another case superficial infection occurred which healed in two weeks time.

Holdsworth et al found loosening of K wires necessitating removal in 56% cases, infection in one, neurapraxia of ulnar nerve in one and hypertrophic scar in one case. They also noted refracture in one case.

Pandit et al reported superficial infection(3), inadequate fixation (3), and stiffness (3). Maini et al

reported superficial infection (3). Thus incidence of complications in our series was nearly in accord with these studies.

To sum up, in our present study we found excellent results in 62.5%, good in 25% and poor result in 12.5% cases which were comparable to results of Pandit et al. who reported results as excellent 75% and good 25%. Maini et al reported results as excellent 46.15%, good 46.15% and fair in 7.7% while Holdsworth found results as excellent in 43%, good in 42% and poor in 15%. Thus our results are nearly comparable to study of Holdsworth.

## PATELLA

In present study eight cases were treated by tension band wiring. All cases were male with an average age of 36.2 years.

Dudani and Sancheti treated 15 cases of fracture patella by tension band wiring. In that series 80% cases were in 20-50 years age group and there were 10 male and five female cases. Bostman et al (1981) treated 21 cases of fracture patella with an average age of 42 years. Hung et al (1985) treated 139 fracture patella by various methods of tension band wiring. In that series 61% cases were male and patients were in age range of 23-76 years and 70% of them were in age range of 50 to 70 years.

Shrinivasalu et al in their study included 15 cases and majority was in 21-50 years age group.

Maini et al (1986) treated 60 cases of fracture patella and there were 40 male and 20 female cases with an average age of 35.55 years. So male preponderance found in our series might be due to their dominance and out door life.

In present study mode of injury was by road accident (25%) direct trauma (12.5%) and by fall(62.5%). Maini et al in their study reported mode of injury to be road accident in 45% and direct blow in 20% cases. Hung et al reported mode of injury as simple fall (87%), direct flow (24%) and traffic accident (21%). Thus incidence of various modes of injuries found in our series is nearly similar to that of Hung et al.

In present study radiologically fracture line was transverse (50%), polar (25%) one in upper and lower pole each, and comminuted (25%). One of polar fractures was compound type I and other were simple.

Hung et al in their series reported transverse fracture (53%), polar 27%), comminuted (18%) and vertical fractures (2%). In other series mainly transverse fractures were selected. Maini et al included 70% transverse and 30% polar fractures. Dudani et al treated fracture patella in which 72.6% were transverse and remaining 26.4% were comminuted. So we had incidence of comminuted

fractures comparable with that of Hung et al and Dudani et al. Remaining radiological type had varying incidence in various series.

In our present series cases were operated on an average of 16.4 days after injury. Dudani et al operated cases within 1-9 days while Bostman et al and Shrinivasalu et al operated within 24 hours. This delay in operation was again due to late arrival of patients and time lag to get investigations and surgical facilities available.

In present study external splint in post-operative period was removed at 10th day in 75% cases but in two cases (25%) it was removed at three weeks. This delay in removal of splint was due to comminution present in one case and fixation in that one was not sufficient to allow early movement. In other case that was compound and associated with extensive damage to extensor expansion, splint was removed late. Average time of post operative immobilisation was 15.5 days.

Dudani et al removed splint between 11-14 days Maini et al removed splint routinely from 10th to 14th day. Hung et al removed splint within first week in 90% cases.

In this study we observed quick recovery of movements and quadriceps strength. At four weeks follow up flexion movement was $<90^{\circ}$ in three, $90-120^{\circ}$ in four and $>120^{\circ}$ in one and at the end of follow up flexion

movement of $<90^\circ$ was in only one case, $90-120^\circ$ in one and $120-135^\circ$ in three cases out of five cases available for check up. Similarly extension lag of $20^\circ$ was present in only one case. This limitation of movement found in one case was due to prolonged immobilisation both in pre-operative and post operative periods because of late surgery and comminution respectively.

Dudani et al in their study of 15 cases reported flexion movements at 8th weeks as $<90^\circ$ in one, $90-120^\circ$ in five and $>120^\circ$ in nine. Similarly some amount of extension lag was present initially in four cases but it disappeared after six months. Maini et al reported flexion movements after six months as $<90^\circ$ in six, $90-120^\circ$ in 24 and $>120^\circ$ in 30 cases.

Thus our results regarding knee movement range were in accordance with those of other series.

In this study we found quick recovery of quadriceps strength. Six (75%) patients were able to lift up straight leg within four weeks and other two in whom splint was removed late were able to do so at eight weeks. After six months power was grade V in four and grade IV in one case.

Maini et al reported straight leg raising at an average of within 25.8 days. Shrinivasalu et al reported grade V power in 93.3% and grade IV in 6.7% cases. So we find that quadriceps power recovery in

view of time and extent was nearly same as in other series.

In our study quadriceps wasting was $<12$ mm in four (80%) and $>25$ mm in only one case at 6 months follow up out of five cases available. Maini et al reported wasting to be on an average 1.1 cm at 12 weeks but at 2 years wasting was found only in two cases and it was 1.5 cm in each. Shrinivasalu et al reported wasting of $<1.5$ cm only in 13.3% cases. Thus our results regarding quadriceps strength and wasting are nearly matching the results of these series. Wasting found in one case might be due to late start of active knee movement because of comminution which did not permit good reduction fixation.

In our series partial weight bearing was allowed earliest when pain and confidence of patients permitted. It was possible to do so in six (75%) cases at two weeks period. In another case with extensor expansion damage it was allowed at four weeks and in yet another patient with comminution in which reduction and fixation was not good and partial weight bearing was allowed at six weeks. Average period at which partial weight bearing became possible was 24 days. Total weight bearing was allowed after union.

Maini et al allowed partial weight bearing at 30.55 days and total weight bearing after union. Hung

et al reported partial weight bearing being possible on an average at two weeks.

Post operative radiographs in present series showed good reduction in 37.5%, step of 1-2 mm in articular surface in 50% and poor reduction in 12.5% cases. Hung et al reported that 32% of their cases showed poor reduction but in these displacement was $\angle 2$ mm. Bostman et al reported step in articular surface of five cases (24%). This difference in quality of radiological results of our series might be due to lack of master hand in technique.

In present series we found effusion in knee joint in one case and later on in same case end of wire loop protruded out of skin. In another case wire loop broken down. Maini et al reported superficial infection (3), Patch of anaesthesia over knee(3), painfull bursitis over wire knots (6) and fatigue fracture of wire loops (4). Dudani et al reported prominence of K. wires in some cases, migration of K. wires (2) and calcification in ligamentum patellae in one case.

Hung et al reported broken wires in 25, chronic infection in one and early osteoarthritis in patello-femoral joint in 11 cases. So we find that complication rate in all these series were nearly similar.

In our study results were excellent in 50%, good in 12.5%, fair in 25% and poor in 12.5% cases.

In this study we found incidence of different types of ankle injuries as adduction in 20%, abduction in 60% and pronation external rotation in remaining 20% cases. Beuchamp et al in their series reported incidence of various types as type B in 67.6% and type C in remaining 32.4% cases.

Burwell et al included 5.2% compound fractures.

In this study we found mode of injury as fall from height in 40%, road accident in 40% and twisting of food during walking in 20% cases. Burwell et al reported that injuries were caused by stumbling in 46% blow on outer or inner side in 7%, fall from height in 10%, fall from stool in 15% and by direct violence in 7% cases. Thus in our study we find that road accident was major cause of injury which might be due to increased vehicles on road these days.

In this series cases were operated within seven days (4), 8-14 days (5), and after 15 days in one case. Average time interval was nine days. Burwell operated 77% their cases within 48 hours and no case was operated after 10th day. Beuchamp et al operated majority of their cases (41) within 24 hours, 13 cases on second day and 17 cases between 3 days to 3 weeks. This delay found in our study was because of late arrival of patients, wait for facilities and unhealthy conditions of skin in some patients.

In present study patients of only medial malleolus fractures were encouraged for active ankle and subtalar movements on 5th day and in these plaster immobilisation was not used. In other two patients with both medial and lateral malleoli fixed internally active movements were allowed from 5th day upto 2 weeks. and after that above knee plaster cast was applied for 6 weeks. In remaining four cases where only medial malleolus was fixed and fractures of lateral malleolus was reduced by closed manipulation, active movements at ankle were not allowed and above knee plaster was applied.

Burwell et al in their series practised active exercises for an average of three weeks and after that immobilised ankle in plaster cast for three to eight weeks. Beuchamp et al practised elevation and active exercises for few days and after that applied walking cast for six to 12 weeks.

In our study postoperative radiographs showed anatomical reduction in 40% and fair in 60% patients. Burwell et al in their treatment of ankle fractures by screw, pins and hook plates reported that anatomic reduction was achieved in 77.2%, fair in 16.7% and poor in 6%.

Beuchamp et al reported that quality of reduction was anatomical in 67.1%, fair in 18.3%, and

Bostman et al in their study found excellent results in 42.9%, good in 42.9% and unsatisfactory in 14.3%. Le Vack et al treated 14 cases by tension band wiring and reported results as good in 50%, fair in 35.7% and poor in 14.3% cases. Hung et al showed excellent and good results in 72% cases by subjective analysis and 81.3% excellent and good by objective analysis. So our results match favourably with results of other series.

## MEDIAL MALLEOLUS

In present study we treated ten patients of fracture medial malleoli. In these four had fracture of medial malleolus only and other six had associated fracture of lateral malleolus or fibula along with fracture of medial malleolus. Patients were in age range of 10-59 years with average age of 32.6 years. All patients were male.

Burwell (1965) et al treated 130 fractures of medial malleoli in 135 patients of ankle injuries by screws, pins and hook and plates. In that series age range was 15 to 89 years. Beuchamp et al (1983) operated 93 patients of ankle injuries ranging from 50 to 80 years. There were 71 female and 22 male patients in this series. Thus we find preponderance of male patient in our series which might be due to chances of exposure for various kinds of trauma were more for male population because of their dominant role in society.

poor in 14.1% cases. Thus although we achieved anatomical reduction in less patients but at the same time we had no poor reduction.

In present study we found that by subjective grading results were good in eight(80%) and fair in two (20%) patients. By objective grading results were good in 90% and fair in 10% patients. This difference in subjective and objective results was because of one patient who had good movement but pain during use of ankle. Burwell et al declared results as good in 82%, fair in 14.3%, and poor in 3.7%. In this series when we considered symptoms we found no pain in 71.9%, aching after use in 28.8% and slight disability in walking in only 14.4% patients. Beuchamp et al reported that there were pain, swelling and weakness in 43.2%, 62.5% and 12.5% respectively. In their series 87.5% were satisfied. They reported that women had 74% movement at ankle joint and 80% movement at subtalar joint while men had 84% and 90% movements at ankle and subtalar joints respectively.

Thus our results are slightly superior to results of Burwell et al who treated ankle fractures by traditional methods. Our results are superior to results of Beuchamp et al who also treated ankle fracture by A.O. methods.

We found complications in present study as delayed healing (30%), swelling over wireloops in 20% cases and superficial infection (20%). Beuchamp et al reported complication in 59.1% patients including marked inflammation(4), infection (8), persistent discharge(6), osteoporosis (2), requiring early metal removal (6) and detah (2). So our patients did not have serious complications found in Beuchamp series.

To sum up we treated 26 fractures of olecranon, patella and medial malleolus by tension band wiring. We found excellent results in 69.12%, good in 15.4%, fair in 11.52% and poor results in only 3.84% cases. So tension band wiring provided good functional results. Factors contributing to achieve this were as follows :

1. Early fracture union with good functional status of joints and these were achieved by dynamic compression at fracture site and movements of joints which itself avoided stiffness and maintained nutrition to cartilage.
2. Efficiency in maintaining smooth articular surface.
3. Good joint movements.
4. Early mobilisation provided by this technique helped much in early rehabilitation for light works. It also helped psychologically.

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# C O N C L U S I O N

## CONCLUSION

The present study "To evaluate the role of tension band wiring as a method of internal fixation in various fractures" was conducted in the department of Orthopaedics, M.L.B. Medical College, Hospital, Jhansi. Twenty six patients of fractures of olecranon, patella and malleolus were selected for this study. Results were evaluated and compared with the results of other series conducted by various workers.

From this study we concluded that tension band wiring for these fractures had certain outstanding advantages.

1. Technique of tension band wiring is simple and it does not require exceptional skill to handle instruments.
2. It achieves early fracture union.
3. It maintains articular congruity.
4. It avoids development of fracture disease.
5. It provides good functional status of joints.
6. With this patients can be rehabilitated at the earliest.
7. It improves socio-economic condition of patients.

Good results found in majority of patients is this series indicate that it is a good method for treatment of fractures of olecranon, patella and medial

malleolus in selected cases. Ours is small series, many more patients should be treated by this technique so that results could be better evaluated statistically. In our view tension band wiring for these fractures is more advantageous than other conventional methods of treatment.

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# B I B L I O G R A P H Y

## BIBLIOGRAPHY


1. Benzamin A : Fracture of olecranon. Watson Jones - Fracture and joint injuries. Vol. II; 6th Ed., 1982.
2. Beuchamp CG, Clay NR, Thexton PW : Displaced ankle fractures in patients over 50 years of age. J Bone and Joint Surg., 65-B; 3 : May, 1983.
3. Bostman O, Kiviluoto O and Nirhamo J : Comminuted displaced fractures of the patella. Injury, Vol. 13; No. 3, 196-202 (Printed in Great Britain), 1981.
4. Brian J, Holdsworth and Mohammed Mossad : Elbow function following tension band fixation of displaced fractures of the olecranon. Injury, 16 : 182-187; 1984.
5. Brook R : The treatment of fractured patella by excision : A study of morphology and function. Brit J Surg., Vol XXIV, No. 96.
6. Burwell HN, Charnley AD : The treatment of displaced fractures at ankle by rigid internal fixation and early joint movement. J Bone Joint Surg (Brit.), 47-B : 634-60; 1965.
7. Colton CL : Fractures of the olecranon in adults. classification and management. Injury, 5(2) : 121-129; 1973.
8. Colton CL : Injuries of ankle, abduction injuries. Watson Jones : Fractures and Joint Injuries, Vol. II, 6th Ed., 1982.

9. Crenshaw AH : Patella, fracture of olecranon. Campbell's operative orthopaedics, Vol. III,7th Ed.

10. Desai Mahendra M : Study of results of different types of treatment in fracture patella. Indian J Surgery, 1972.

11. Donald Macko and Robert M Szabo Sacramento : Complications of tension band wiring of Olecranon fractures. J Bone Joint Surg., 67-A; No. 9, Dec., 1985.

12. Dudani B, and Sancheti KH : Management of fracture patella by tension band wiring. Indian J Ortho, Vol. 15, No. 1; June, 1981.

13. Fletcher S, Sutton JR, Carolyn H, Thompson, Jay Lipke and Donald B Kettelkamp, Little Rock,Arkansos: The effect of patellectomy on knee function. J Bone Joint Surg, 58-A, No. 4, June, 1976.

14. Francis M-Mckeever, Ronald M Buck : Fractures of olecranon process of the ulna. J Am Med Assoc, Vol 135, No. 1, Sept, 1947.

15. Fray H, Gartsman, Thomas P Sulco and James C Otis : Operative treatment of olecranon - fractures. J Bone Joint Surg, 63-A, No. 5; June, 1981.

16. Haxton HA : The function of patella and effect of its excision. Surg Gynaecol Obstet, 80 : 389-95; 1945.

17. Herbety Kaufer, Ann Arbor, Michigan : Mechanical function of patella. J Bone & Joint Surg., 53-A, No. 8 : Dec., 1971.

18. Hey Groves EW : A note in extensor apparatus of the knee joint. Brit J Surg, 24 : 747-748; 1937.

19. Hung LK, Chan KM Chow YN and Leung PC : Fracture patella operative treatment using the tension band principle. Injury, 16 : 343-347; 1985.

20. Keswani, MH : Ancient Hindu orthopaedic surgery. Ind J Orthop, Vol. 1, No. 1, June, 1967.

21. Leung PC; Mark KH, Lee SY : Percutaneous tension band wiring : A new method of internal fixation for mildly displaced patella fractures. J Trauma Vol 3, No. 1 (Printed in USA), 1983.

22. Levack B, Flunn agan JP, Hobbs S : Results of surgical treatment of patellar fracture. J Bone & Joint Surg, Vol. 673, No. 2, March, 1985.

23. Maini PA, Sangwan SS, Sharma S, Chawla P and Kochar A : Rigid fixation of various fractures by tension band wiring. Indian J Orthop, Vol 20, No. 2, 1986.

24. Mathews MH, Mccreath SW : Tension band wiring in treatment of olecranon fracture. J Bone & Joint Surg, 57-B, No. 3, Aug., 1975.

25. Michael J Weber, Chet J Janeckel, Paul Mcleod, Carl L Nelson and James A Thompson, Little Rock Arakansas: Efficacy of various forms of fixation of transverse fracture of the patella. J B & J Surg, 64-A, 2, March, 1980.

26. Mishra US : Late results of patellectomy in fractured patella. Ata Orthop Scand, 43 : 256-63; 1972.

27. Muller ME, Allgower M, Schneider R, Willenegger H : Fracture of the olecranon. Fracture of the Patella, Malleolar fractures, Manual of internal fixation |Technique recommended by the A.O. group| Second Ed. Springer Verlag Berlin, Heidelberg, New York, 1979.

28. Pandit MD, Mehrotra Anoop, Vachharajani NV and Shah VM: Evaluation of results of olecranon fractures treated by tension band wiring. Ind. J. Orthop. 20(2), July, 1986.

29. Retting AC, Wough TR and Evans KPM : Fracture of olecranon : A problem of management. J. Trauma, 19 : 23-28; 1979.

30. Shrinivasalu K, Sanjiva KS Marya, Surya Bhan and Dave PK : Results of surgical treatment of patellar fractures. Indian J Orthop, Vol.20, No. 2, July, 1986.

31. Wander Kloot, JF VR : Results of treatment of fractures of olecranon. Arch Chir Neerlandicum, 16 : 237-249; 1964.

32. Wain Wright D : Fractures of olecranon process. Brit J Surg, 29 : 403-406; 1942.

33. William A Phillips, Herbert S, Schwartz Cary S Keller, H Randal-woodward, Steven Rudd W : Philip G Spiegel and Geral S Laros : A prospective randomised study of the management of severe ankle fractures. J Bone & Joint Surg, Vol. 67-A, No. 1, Jan, 1985.